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ABSTRACT

The function of the research-related activities of universities in countries belonging to the Organization for Economic Co-operation and Development (OECD) is examined. Additionally, the extent to which the universities are affected by the demands placed upon them, and implications of the situation for the future well-being of the scientific enterprise in OECD countries are addressed. The kinds of pressures acting on the university systems of member countries include: fluctuations in student enrollments; slow-down in the growth of financial resources and a change in the balance between the sources of research funds; government pressure for what is considered to be socially relevant research; and the effects of changing social values (democratization, employment protection, and the growth of bureaucratization of university research). Responses to these constraints include: new modes of distributing resources, separation of teaching and research, stratification of institutions and staff, and recruitment and mobility. It is suggested that in many member countries, national science policy bodies, or research funding bodies, continue to formulate priorities that have no reference to what scientists regard as worthy of study. Policy implications of trends toward separating research from teaching and of funding research to a certain proportion of the total number of universities are considered. Additional concerns include: flexibility of research performance, enrollments in postgraduate degree programs, availability of equipment for research, and performance of applied versus basic research. (SW)

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The future of university research

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FOREWORD

The importance of university research is not only due to the fact that it is research - which should predominantly consist of strategic, long-term research - and that, as such, it plays a crucial part in ensuring the balance and quality of the overall R&D effort. Its uniqueness resides in the fact, stressed in the present report, that it fulfills a number of functions and that its influence extends to the education, economic, social and cultural spheres in a comprehensive way that has no equivalent in any other segment of the research system. The reverse side of the coin is that it is often affected by the unintended consequences of decisions or trends taking place in any of these spheres.

Unsurprisingly, therefore, university research *per se* is not the subject of a coherent system of policy-making and management. University scientists have become increasingly aware of the multiplicity of pressures and demands they must take into account and which often appear as additional constraints hampering their ability to carry out research, and at the same time, policy-makers concerned with the health of the research effort have become painfully conscious of the limitations on their ability to affect - and improve - a research function which is so sensitive to many influences beyond their control.

Misunderstandings and tensions between the scientific and government worlds are bound to develop in such a situation - the more so when it is recognized that there is no objective, fully reliable data-base which could provide at least a generally accepted diagnosis of the situation. Available statistics which attempt to give an indication of the financial and human resources invested in university research, or of the distribution of the research effort among fields of science and institutions, are often challenged. Attempts are being made to produce more sophisticated indicators of the "outputs" of research - but it must be recognized that these efforts remain limited and that, as far as university research is concerned, they will never provide a comprehensive, totally reliable picture.

Better ways of assessing certain aspects of the research effort should of course continue to be sought, but the inherent limits of these attempts are such that they should be seen as a contribution to - and not a substitute for - the continuing dialogue between performers of research,

consumers of scientific knowledge and policy-makers. Any assessment of the strength, quality, relevance and effectiveness of research will necessarily rely above all on the various perceptions of all those who, for one reason or another, have a stake in it.

The present report has attempted to take account of the "objective" data available, while reflecting the views of scientists and policy-makers. The picture which has emerged is in many ways a disquieting one, where university research is called upon to adapt to a new era characterized by slower growth and complex demands, but where it is largely left to fend for itself in the face of multiple - and at times contradictory - pressures.

Although the likely consequences of this situation are open to discussion, it seems clear that policies which take account of the special circumstances and diverse functions of university research are needed if the health and standards of the entire research system are to be maintained.

It is broadly recognized that the future economic health and social development of industrial societies hinge on their ability to exploit the opportunities provided by science and technology and to found growth on the capacity to innovate. There is a serious risk, however, that this pre-occupation will prompt policies that will attempt to harness the scientific effort to short-term needs and instant "pay-offs", rather than to achieve and maintain the balanced construction of a solid scientific base which will ensure both the new opportunities and the skilled manpower to exploit them.

The political, social and economic uncertainties of technological innovation have become only too painfully obvious and, unlike the people in Ambrose Bierce's tale of the "Flying-Machine" (1), decision-makers will increasingly demand evidence of feasibility, safety and profitability before launching new technological undertakings. More than ever,

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1) Ambrose Bierce - Fantastic Fables, G.P. Putnam's Sons, New York, 1898 - republished by Dover Publications Inc., New York, 1970, page 16.

"An Ingenious Man who had built a flying-machine invited a great concourse of people to see it go up. At the appointed moment, everything being ready, he boarded the car and turned on the power. The machine immediately broke through the massive substructure upon which it was builded, and sank out of sight into the earth, the aeronaut springing out barely in time to save himself.

'Well', said he, 'I have done enough to demonstrate the correctness of my details. 'The defects', he added, with a look at the ruined brick-work, 'are merely basic and fundamental'.

Upon this assurance the people came forward with subscriptions to build a second machine".

perhaps, knowledge of the fundamental processes in nature and society have become the pre-conditions of innovation.

Thus, one of the prerequisites for university research of a strategic, long-term nature is the ability of industrial societies to engage safely in the continued quest for scientific and technological advance. In this sense, the universities' potential as producers and custodians of knowledge and of highly skilled personnel is an essential investment for the future of each of the countries concerned and - because of its inherent international ramifications - a key resource for the OECD Member countries as a whole.

This study was undertaken within the context of the programme of work of the OECD Committee for Scientific and Technological Policy in response to the increasing concern expressed about the future of the scientific enterprise, and in particular, the role of university research.

The report was prepared by Stuart Blume, Michael Gibbons, Sheila Kelly and Wouter van Rossum, under the direction of Georges Ferné.

It was discussed at a meeting of senior government officials responsible for research policy in May 1980, at which it was emphasized that university research, through its multiple functions, is an indispensable asset for all Member countries, particularly as the source of knowledge upon which future innovation will be based.

INTRODUCTION

This study has its origins in the increasing concern expressed in several Member countries about the future of "academic science" - that is to say, the research function of the universities, which have traditionally served as the point of origin for fundamental, innovative research and, hence, its possible applications.

The research function of the universities is, indeed, undergoing a series of profound changes induced by social, economic and political forces. Though some of the changes in the performance and the environment of such research are becoming increasingly visible, their implications - particularly from the point of view of the quality and future development of the national research effort - remain unclear.

The role and functions of the universities in the national R&D effort are not, however, confined to carrying out research of high quality; they include the maintenance of scientific standards, the provision of the skilled manpower required by industry, government and other sectors of society and, more fundamentally, the accumulation of knowledge and understanding.

The purpose of this study is, then, to examine the function of the research-related activities of the universities in Member countries; to say something about the extent to which they are affected by the various demands placed upon them and to make some preliminary assessment of the implications of the situation for the future well-being of the scientific enterprise in Member countries.

Whilst it is clear that university research is indeed encountering difficulties in many Member countries, these differ not only in their extent but, more strikingly, in their causes and their nature. The factors which affect the performance of research in the universities relate to the fact that university research has a number of distinct functions, and that problems may, and do, emerge in relation to the performance of any one of them. For convenience, these functions are listed as follows:

University Functions in respect of:

The National Research System	Maintenance of scientific infrastructure across all fields of science. Maintenance of capacity to develop potential in new fields of science. Sustain national centres of expertise in selected areas. Stimulate emergence of new conjunctions of ideas and hence the development of pluri-disciplinary research. Maintenance of scientific standards.
The Education System	Production of future generations of scientists through training in research methods. - The quality of undergraduate teaching and introduction to research methods.
Economic and Social Systems	To carry out the basic work necessary to underpin future innovation. Contribute to innovation in public policy areas through 'strategic' research. Applied research for industry, community, government. Provision of consultants for industry, government departments and the community.
The Cultural System	The advancement of knowledge. Fostering of individual, communal and national self-awareness. National identity: interpretation of national culture, heritage.

There are three points to be considered in relation to these functions. First, the extent to which any one of them is the sole responsibility of the university varies between countries - for example, the proportion of "basic" research performed by the universities varies widely from one country to another. Second, the relative weight attached to each of these functions within the university system also varies between countries, as illustrated, for example, by the distribution of university research between "fundamental" and "applied" in the various countries. Here, however, a caveat must be entered concerning the definition of "fundamental" research, and hence the possibility of measuring it.

Finally, the effectiveness with which the university system is seen as performing any one of its functions varies not only between countries, but between interested groups within any one country. This results from the fact that each national research system reflects a specific historical heritage, which affects its organisation as well as its performance and the range of expectations attached to it by potential "clients".

Seen from this point of view, then, the "problems" or "concerns" of policy-makers relate to factors which may threaten the effective

performance of one or another of the universities' research functions. They also reflect the relative importance attached by policy-makers to these various functions - for example, problems in relation to industry are likely to have greater salience in most countries than are problems related to culture, historiography, or astronomy.

The capability of any university research system is influenced by many factors: the pressure of student enrolments, which of course depend upon demographic trends; financial resources; general socio-political values and legislation (relating, for example, to protection of employment or "democratisation" of decision-making); the system of post-graduate education, and so on. As a consequence of these trends, of the operation of government policies for science and for education, and of internal pressures generated from within the university, major structural changes have emerged within the university system. One example is an increasing separation between research-based and non-research based institutions.

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Although it is not the purpose of this report to analyse in detail the diverging views as to the proper functioning of the universities which may emerge between, say, government science policy bodies on the one hand and the scientific community on the other, the existence - and avoidance - of conflict may have major implications for the operation of the university research system. It may also have major implications for the role of research councils, which to a certain extent are required to function as intermediaries between government, or society, and the scientific community, reconciling what may be increasingly divergent demands and aspirations.

Chapters I and II of this report present evidence relating to the nature of the constraints which now affect university research, and attempt to analyse the effects of these constraints in terms of both unintended consequences and of deliberate strategies designed to cope with present difficulties. The third chapter suggests how current pressures and trends are affecting the future capacities of university research systems to respond to demands which will be made on them in coming years and attempts to bring into focus certain areas which seem to call for governmental action and choices.

Ideally, such an analysis should be based upon, on the one hand, an examination of those factors likely to influence the research capacity of universities (resources of men and money, organisational structures) and, on the other, of the "output" from these systems. Such outputs would correspond to the functions already described: the output of scientific knowledge, of scientific manpower, etc. Some preliminary

attempts at "input-output" analysis for science have been made, notably in the United States. However, not only are equivalent output data not available for the majority of OECD countries, but major conceptual difficulties surround the development of output measures ("science indicators"), and we have not found it practicable to proceed on that basis. Notwithstanding the work that has already been done on science indicators, the validity and reliability of output (and to some degree even input) measures of the scientific effort are still questionable. Rather than engaging in a comparative and quantitative input-output analysis, therefore, the arguments in this report are exemplified by pointing out tendencies in some Member countries.

Particularly in the case of the quality of university research, one may even question the meaningfulness of a quantifying approach to obtain a picture of the "health" of the university research system. Perhaps, at this stage, the most unequivocal indicators of the output of the system is the number of Ph.D. degrees granted per year. This gives a direct output from research as well as an indirect contribution to the various sub-systems outlined earlier (e.g. by supplying manpower). But of course formal Ph.D. programmes do not exist in all countries, and there are in any case no up-to-date comparative statistics on Ph.D. outputs.

Finally, it is emphasized that this is an interim report. As such, it must be borne in mind that it is not based on a comprehensive investigation and analysis of the situation in all Member countries, only some of which (1) could be visited because of both the time available and budgetary constraints. Obviously, the wealth and diversity of experience in Member countries would justify continued investigation and discussion. As it stands now, however, it is hoped that the analysis contained in the report will provide most governments with some indications of necessary action and shed light on certain important questions which merit further and fuller investigation.

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1) Canada, Germany, Greece, the Netherlands, Sweden, Switzerland.

Chapter I

DEMANDS ON UNIVERSITY RESEARCH SYSTEMS

The diversity of functions which university research is called upon to perform is emphasized in this report in order to draw attention to the serious and manifold implications of any major deterioration in the working of the university research system. But the complex interactions of this system with other aspects of social action - e.g., the educational system, the social system, the economic system - have other implications for both the universities and society, because the research system is necessarily sensitive to changes in these systems.

Thus, in order to understand the environment to which the university system is expected to adapt, it is necessary to take account of the legacy of changes in each of these systems. Whilst explication of all of this, in an historical perspective, is beyond the scope of this report, a number of points can be made here.

First, it must be recognised that universities have been, and still are in most countries, regarded from a policy point of view principally as educational institutions. Whilst the share of the age-cohort to which higher education (or university education, as its elite form) is made available differs from one Member country to another, yet these "participation rates" are everywhere such that higher education is now available to a very large number of young people. For this reason, as well as the commitment of public resources involved, higher education has acquired a degree of political visibility, and therefore it is educational considerations which, for good or ill, have largely determined the structure of higher education in most countries - including, for example, decisions as to how the expansion of the 1960s was to be accommodated. In other words, educational policy and the changing demand for university education have been, and continue to be, the major determinants of the nature of the university. It is the implications of such policies, and of changing demand, for university research which have to be considered here.

As universities have grown, and become more politically visible so they have come to be seen in the light of more general political values. Thus, higher education policy has become an arena, like others, for

political debate and the expression of competing political beliefs. Hence the growing concern with "accountability", "efficiency", and "productivity" and the attempts in some countries (especially the Nordic countries) to promote equality of access between age groups, social groups and the sexes. Similarly, universities have felt the effects of a growing concern with "democratisation", especially of decision-making, which developed in the 1960s. In the United States, for instance, the impact of social legislation upon universities' hiring practices meant that they were required, increasingly, to move towards greater representation of minority groups and women in their faculties. Social legislation has also extended, more recently, to the provision of greater security of employment. Here, too, changing social values have led to legislation directed at the socio-economic system broadly: its implications for university research could never have been seen as a major consideration, but from the universities' point of view they are far from insignificant.

Finally, of course, the seemingly intractable problems of today gradually emerged: inflation, unemployment, the energy shortage, and so on. Through their training and through their research, the universities have been required to make their contribution to coping with - or hopefully resolving - such problems, and in most Member countries there has been a growing concern to make university research more "relevant" to socio-economic concerns.

The sorts of pressures acting on the university systems of Member countries may therefore be considered under the following headings:

i) fluctuations in student enrolments;
ii) slow-down in the growth of financial resources and a change in the balance between the various sources of research funds;
iii) government pressure for what is deemed to be "socially relevant" research;
iv) the effects of changing social values: "democratisation", employment protection and, not unrelated, the growth of bureaucratisation of university research.

1. CHANGING ENROLMENTS

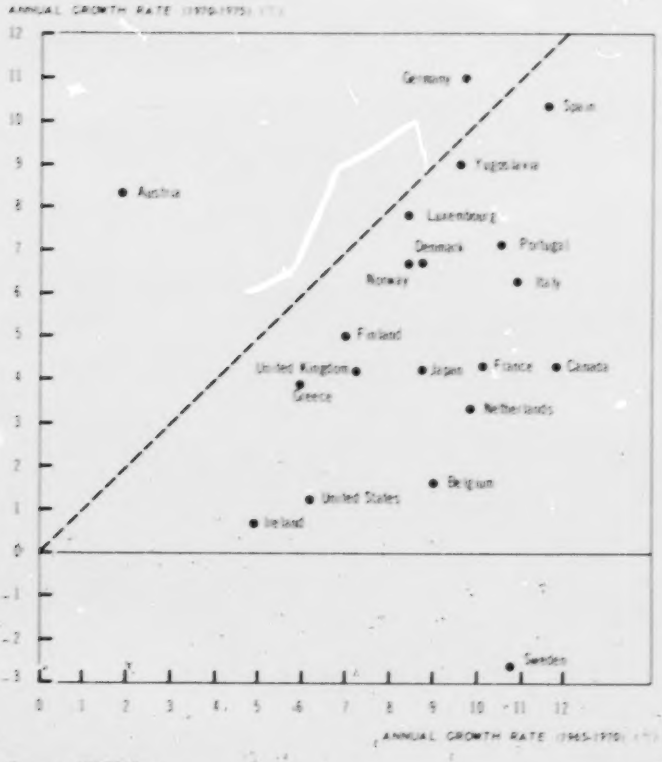
Because of the immediate post-war increase in the birth-rate, the age cohort eligible for admission to higher education in the mid-1960s was exceptionally large. The affluence of those years in the OECD countries meant that policy almost everywhere was concerned with access to higher education. Countries which had always had a policy of relatively unrestricted admission retained this principle, and those (such as

the United Kingdom) which had been selective in their admissions policies nevertheless planned for substantial growth.

In fact, as has been discussed in previous OECD studies (1), this expansion of student numbers was accommodated in a variety of ways: by expansion of existing universities; by the creation of new universities (sometimes of an experimental kind); by very much more rapid expansion of the vocational, non-university sector of post-secondary education which in most OECD countries ran (and runs) in parallel with the universities. However, though in some countries this non-university sector came to occupy a quantitatively greater place in the total provision

Graph 1

ANNUAL GROWTH RATE OF UNIVERSITY TYPE ENROLMENT
(1965-1970, 1970-1975)



Source : OECD data.

1) i.a., Development of Higher Education, 1950-67: Statistical Survey, and Analytical Report, OECD, Paris, 1970 and 1971; Policies for Higher Education, OECD, Paris, 1974.

of student places (for example Ireland, Japan and the Community Colleges in some States of the United States), in almost all countries the traditional universities expanded at a greater rate than ever before.

By the mid-1970s the situation had changed. Although in almost all Member countries enrolments in universities were still growing in 1975, the rates of growth had dropped very considerably. The quinquennia 1965-1970 and 1970-1975 are compared in Graph 1, which shows that only in Austria and Germany have the more recent expansions been more rapid, and that in Sweden the university system actually contracted in the early 1970s. More recent data on new entrants (a more sensitive indicator), relating to the period 1975-1977, show that there is now almost no growth (The Netherlands being one exception) in the OECD area. On the basis of demographic change alone (i.e. taking no account of changes in demand for higher education, which may indeed be falling) the situation is unlikely to reverse itself in the early 1980s.

Changes in enrolment have important implications for university research. The two are related through financial links, faculty recruitment, and post-graduate education. In most countries the major determinant of the income which universities receive from the State is the number of students to be taught. In fact, what seems to have happened in many cases is that this income has not quite kept up with expansion, when corrected for inflation. This has meant that, once personnel have been paid, and when teaching material has been provided, a diminishing volume of resources has been available to the universities for actual research. Whilst the implications of this will be discussed later, it is worth pointing out here that it is a matter of concern even in those countries (e.g. Germany) where alternative sources of research funds are still quite freely available.

The second crucial link is through the implications of changing enrolments for recruitment of university staff. In the 1960s, as the expansion in enrolments was accommodated, there was rapid recruitment and the opportunities for those seeking an academic career were never better. Many young scientists were recruited to senior posts in new universities and to new posts in old universities. The age structure of university faculties was far younger overall than (perhaps) it had ever been before. In the limited, or zero, growth in enrolments which has followed, there has been little or no new recruitment. One effect of this has been that university staffs have aged together (with almost inevitable effects on research performance). Another effect is upon morale, as those in the more junior posts recognise that Professorial posts are likely to remain filled (and hence unobtainable) for years or even decades to come. A third effect, very visible in Germany, has been discouragement of even

the most scientifically promising students to embark upon study for the doctorate. It has been all too apparent that there simply was little likelihood of a university career being possible.

There is a further aspect of this particular matter. In many countries it has come to be recognised that the rapid expansion of the 1960s was accomplished sometimes at the expense of quality, or of research ability, and that these appointments of a relatively young cohort tend to block opportunities for the trained talent available for years to come.

The third link between student enrolments and university research is provided by post-graduate education. The numbers entering the university provide the "pool" of graduates from which, a few years later, some will go on to do research. In fact, this linkage is complex because "post-graduate education" is a concept which has very different meanings from one country to another. (1)

In some countries a policy was to offer financial support for doctoral study to a fixed proportion of the numbers graduating. In others, lacking the formalised and distinct educational cycle leading to preparation of the doctorate on the American model (e.g. Finland, Norway, the Netherlands), the major determinant of numbers proceeding to prepare the doctorate was rather the number who could be employed, either as research assistants or on project grants. Here, and in countries such as Greece which lack any significant volume of project finance, it has been the absence of junior Assistant posts, and to some extent the changing availability of project finance, which has been determinant.

At the same time, it has been suggested that in a number of cases scientists (especially in the social sciences and humanities) are simply disengaging from research (for a variety of reasons to be discussed later) and so are less and less willing to supervise doctoral work.

Finally, in Germany and the United States there are strong indications that market forces, and recognition of where career opportunities lie, are most important in determining what proportion of students proceed to doctoral study. In other words, the size of the graduating cohort does not seem to be the major determinant of the numbers embarking on doctoral study, although it obviously sets an upper limit. It does however appear that the scale of doctoral work in many OECD countries is declining. It is not possible to document this statistically, since there have been no recent comparative reviews, by statistical trends, in post-graduate enrolments or output.

Sweden, however, provides an interesting example (Table 1), where

1) i.a. Postgraduate Education : Structures and Policies, OECD, Paris, 1972.

despite rising enrolments in doctorate studies, there has been a precipitous drop in the numbers completing doctoral work.

Declining doctoral level work has a number of implications. First, for the health of the national R&D system, since highly trained scientists will be crucial to any future expansion or change of direction. Second, for the well-being of the research potential of the universities themselves since, particularly in the natural sciences, post-graduate students, as part of their research training, have traditionally served as the "willing hands" of more senior scientists and actually carried out much of the routine work involved in research. In addition, they have traditionally taken part in supervising the laboratory work of undergraduates - hence freeing senior academic staff for teaching or other research work. Thus, any major decline in output in the first case and in numbers being trained in research in the second, are potentially serious.

One further point may be made. It is frequently claimed by academic staff that the expansion in student numbers has limited their research by reducing the time available to them for research - more time being taken up in teaching. The validity of this argument seems doubtful, the more so in times of declining student numbers. It may have some truth insofar as laboratory supervision (in disciplines where this takes place) is certainly "labour intensive". But this aspect of instruction is largely, and can be further, delegated to Assistants or research students. Nevertheless, the point is frequently made, and was cited by some 25 per cent of those German University scientists who, in response to a (1976-77) inquiry (1), considered the situation of research to have deteriorated over the previous three years.

2. FINANCIAL RESOURCES

Because the principal expenditures of universities are those associated with salaries, student numbers are one major determinant of the financial situations of universities. Income derived from, or based on, student enrolments is a major and important element in the finance of the activities of the universities. The 1960s were a period of expansion not only in student numbers but in financial resources also; similarly the 1970s saw a levelling off in both parameters.

Whilst this is generally true for most Member countries, it is in fact possible to distinguish two somewhat different patterns in the relationship between growth of student numbers on the one hand and the

1) Untersuchung zur Lage der Forschung an der deutschen Universitäten (Allensbacher Enquête, 1977).

Table 1

NUMBER OF STUDENTS FOR PhD-DEGREES(N) AND NUMBER OF PhD-DEGREES(r) IN VARIOUS FIELDS IN SWEDEN

index 1969 = 100

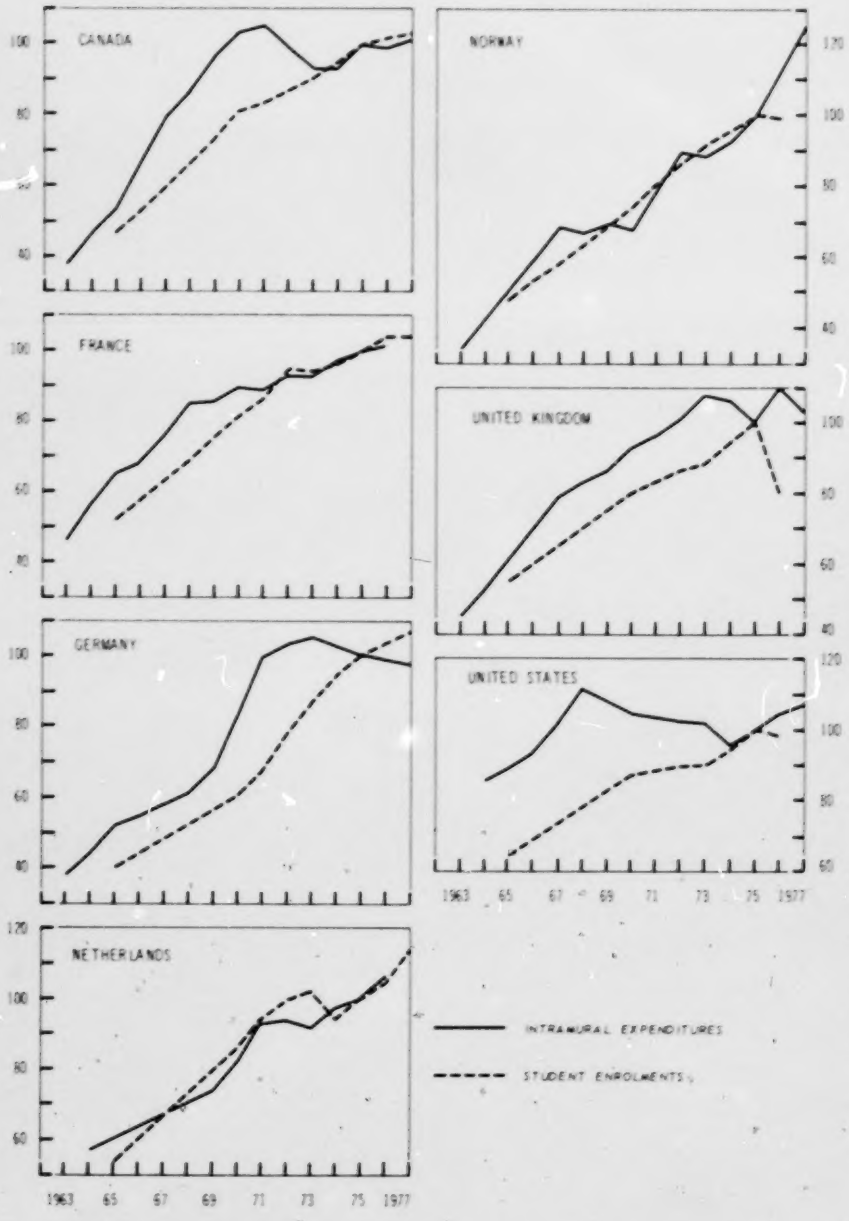
Fields \ Academic Years	69/70		70/71		71/71		72/73		73/74		74/75		75/76		76/77		77/78	
	N	r	N	r	N	r	N	r	N	r	N	r	N	r	N	r	N	r
Medicine	100	100	118	105	132	129	141	131	153	239	161	124	172	142	174	135	194	116
Humanities	100	100	110	127	124	122	126	97	129	82	132	68	138	47	143	55	142	50
Social sciences	100	100	146	168	189	207	106	164	104	116	103	97	107	83	97	75	113	67
Natural sciences	100	100	100	130	103	103	115	80	112	74	108	56	110	46	109	52	105	57
Engineering	100	100	112	135	121	111	115	114	127	123	127	66	138	82	142	61	151	70

Source: OECD data.

Graph 2

TOTAL INTRAMURAL EXPENDITURE ON RESEARCH IN THE HIGHER EDUCATION SECTOR AND STUDENT ENROLMENT IN UNIVERSITY TYPE HIGHER EDUCATION

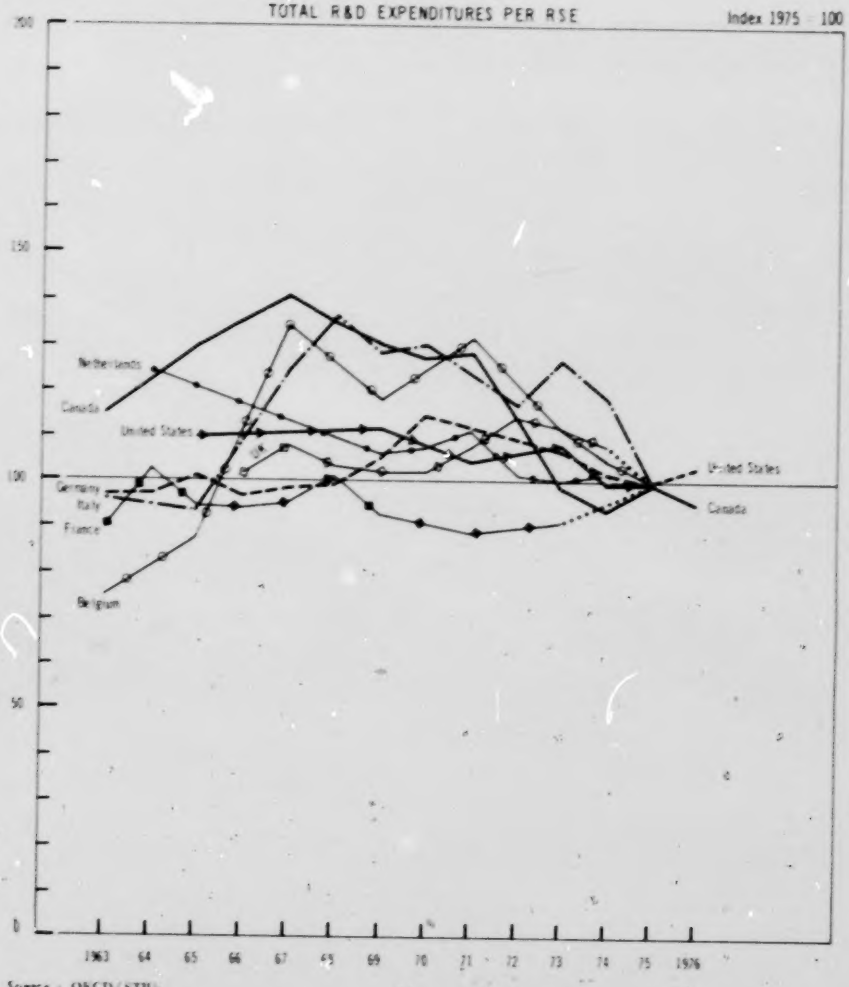
(1975 = 100)



Source : OECD data.

financial resources available for university research on the other. In Graph 2 the relationship is displayed for a number of countries with a description of the evolution of total intramural expenditure on research in the higher education sector (at fixed prices and setting 1975 = 100) and of the growth of student enrolment in university-type higher education (again setting 1975 = 100). This graph shows that for one set of countries (Canada, France, Germany, United Kingdom and the United States) the growth in research expenditure exceeds that in growth in student numbers during the 1960s. Subsequently, in the cases of Canada and France in particular, levelling-off led to equalisation of growth rates. Developments in the United Kingdom, the United States, and Germany after 1975 have not been entirely consistent with this pattern.

Graph 3



Source : OECD/STIU.

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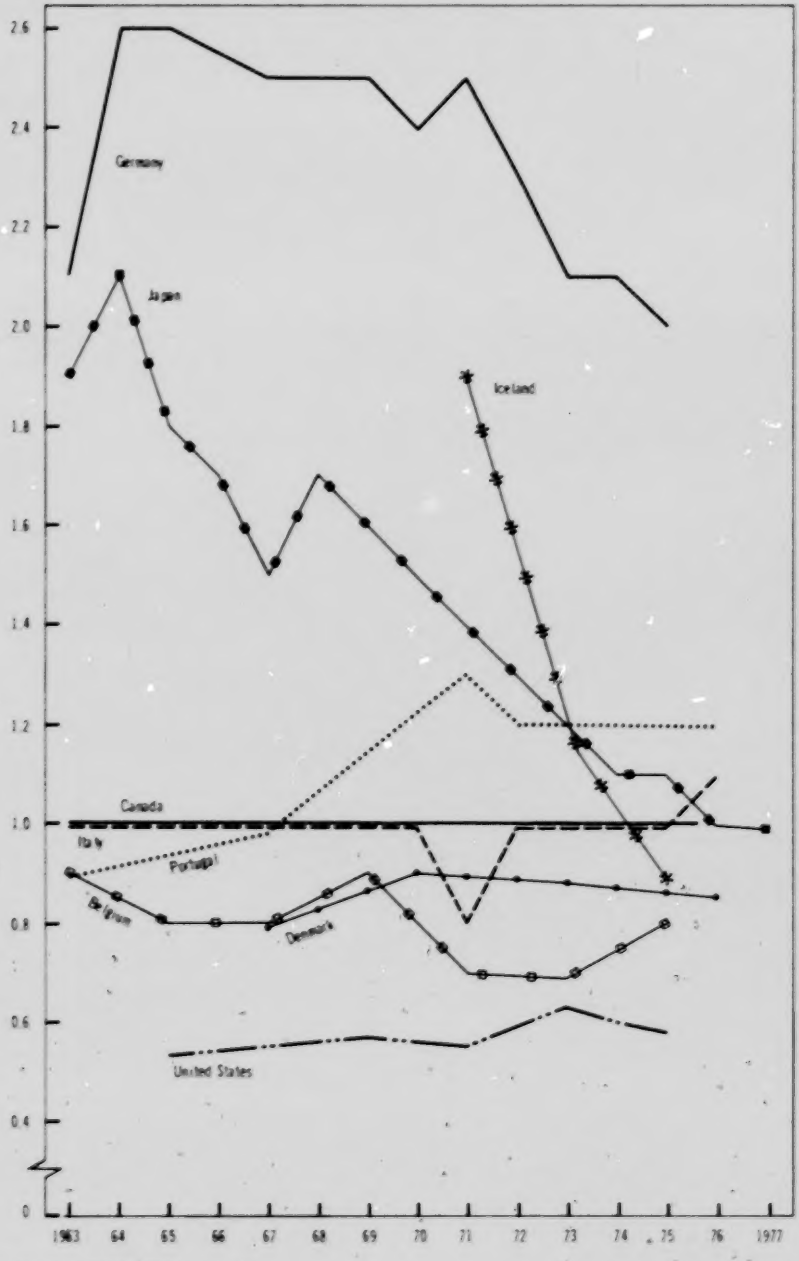
Graph 4

SUPPORTING STAFF PER RSE



Source : OECD/STIU.

On the other hand the growth patterns of both indicators in the two smaller countries shown (the Netherlands and Norway) differ considerably from the pattern shown by the other countries. Here, during both 1960s and 1970s, growth in research expenditure more or less paralleled growth in student enrolment.

It might be concluded, then, that for the first group of countries the research function (at least in resource terms) acquired a growing importance relative to teaching during the 1960s. In the second group of countries the two have always remained more or less in the same balance, and the 1960s do not appear as a period of "plenty" for research.

The major giving rise to this difference in patterns of growth is the availability, or not, of research resources from outside the general funding of universities ("GUF"): that is to say, grant and contract funding. As discussed later, the availability of these external funds differs substantially from one country to another although comprehensive data on the changing balance between these two kinds of funds are not available.

Table 2 and Graphs 3, 4 and 5 give some support to the conclusion that the expansion and contraction of research in the universities seems to have followed the movements of national economies generally. It is difficult to perceive, on the basis of this statistical evidence alone, how such fluctuations are converted into pressures on university research which are in any way more serious than those experienced by other institutions trying to manage on declining budgets.

a) Aggregate Funds

It is possible that university funding in the aggregate masks other more serious changes which are taking place in the lives of the universities, and that it is these changes which consistitute the main constraints. The aggregate of funds available to universities are divided first among the individual universities, then among faculties, departments, research groups and, in some cases, following the traditional pattern, among individual scientists. Apart from the comments, and in some cases the complaints, of scientists it is not very easy to identify the effects of macro-economic fluctuations on the research styles of individual scientists.

In recent years there has been no shortage of criticism from the universities to the effect that there has been a gradual and pervasive deterioration of the working environment of their scientists - in terms of new capital equipment, working space, support staff, research students, and other essentials. Policy makers are invited to recognise that the maintenance of a strong university research capability is of national

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(and perhaps international) importance and thus justifies the implementation of policies designed to offset the negative impacts of shrinking university budgets.

Another way of looking at the problem, which receives little or no expression in the universities but merits consideration, is to define it as the "overpopulation" of the university R & D system. The influx of researchers into the universities in the 1960s was mainly related to increasing enrolments, and R & D funds in most countries kept well abreast. New equipment was purchased, and research assistants (or "willing hands") were found among the graduate students. Nowadays, the researchers are still there, while funds (particularly on a per capita basis) are not expanding.

A "mechanistic" approach to handling the problem might have been to lower the number of researchers, so that those remaining would have the facilities necessary for high-quality research. However, to be pursued rationally, such a course would require identification of the most productive, or valuable, research scientists, whilst the rest are transferred into teaching, administration, or other institutions. The difficulties in the way of such a policy are, of course, considerable: ranging from the very questionable ability to identify the best researchers to the implications of job security legislation. If one assumes that a continuing diminution in funds is an inevitable consequence of the current economic climate, such a draconian approach seems inevitable if university research is not gradually to become insignificant.

Both these perspectives rely upon a similar analysis of the deteriorating situation of university scientists. Some data are available, and evidence can be provided on three aspects of the university research environment:

i) trends in expenditure per research worker;
ii) trends in support staff per research worker;
iii) trends in the obsolescence of capital equipment.

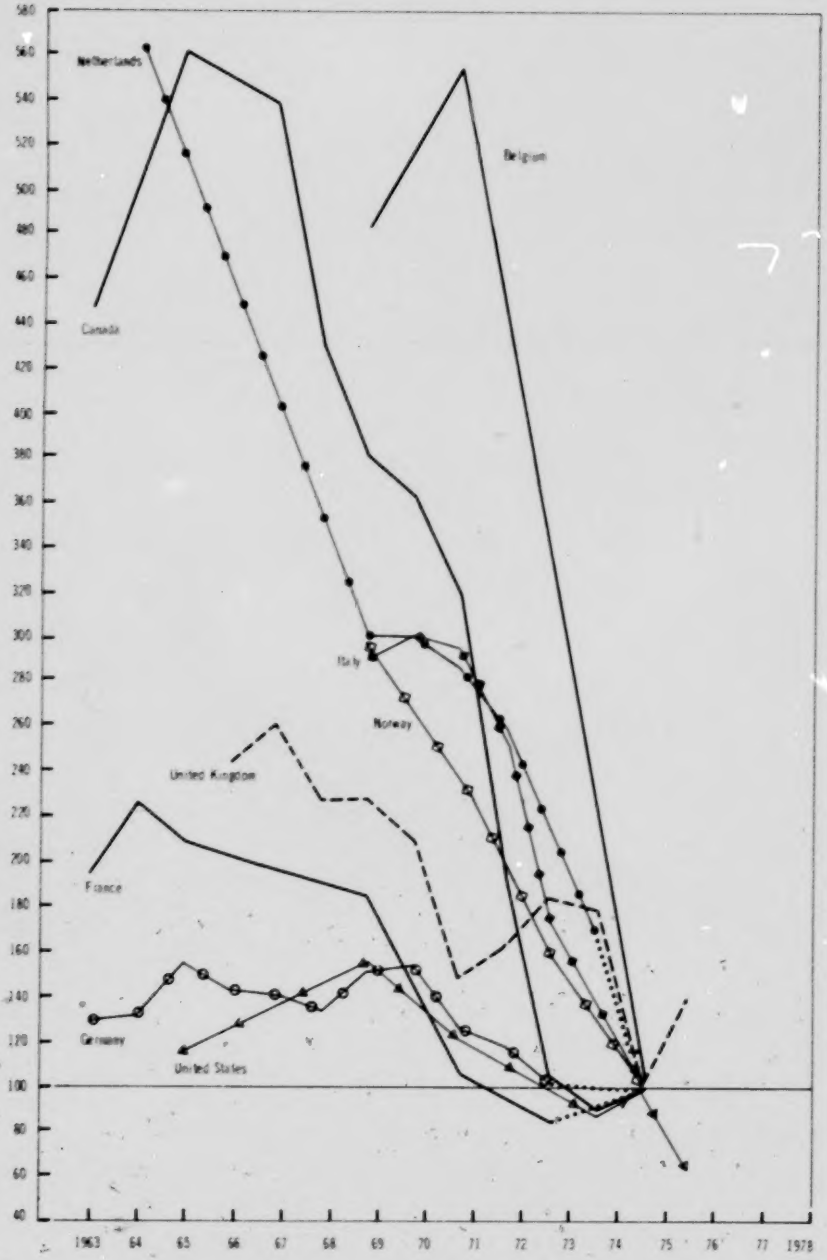
International comparisons of the trends in expenditure per research worker are given in Graph 3, from which it is possible to deduce that in most countries the total expenditures on R & D per research scientist or engineer (RSE) has remained more or less constant. In the Netherlands, the United States and Canada, trends have been generally downward, while in Germany and France they have been upward. Throughout the period, the United Kingdom has remained more or less constant in terms of this indicator.

Similarly, the numbers of supporting staff per RSE have remained more or less constant, with the exception of Germany and Japan (see Graph 4). In the case of the former there was a large expansion of

Graph 5

CAPITAL R&D EXPENDITURES PER RSE

Index 1975 = 100



Source : OECD data.

support staff between 1964 and 1973 but hereafter numbers have decreased below the 1964 level. By contrast, in Japan the support staff per RSE has declined steadily since 1964.

Obviously, on the basis of these two graphs alone, it is difficult to conclude that the research environment has improved but, equally, any deterioration must be judged to be slight. The same, however, cannot be said when one looks at the pattern of investment in capital equipment.

The expansion of the universities during the 1960s included the creation or refurbishment of laboratories for both undergraduate teaching and for research. The gradual contraction of resources subsequently has meant that existing capital equipment has not been replaced. This is clearly demonstrated by Graph 5 which shows a sharp decrease in capital R&D expenditure per RSE from about 1968 to 1976.

This decline in capital expenditure per RSE, usually referred to as the "problem of obsolescence", is a source of concern within the universities of nearly all OECD countries. Not only are research scientists unable to re-equip their laboratories, but undergraduates in science and engineering are now frequently being trained on scientific apparatus no longer being used in some government or industrial research establisments. The ways in which universities are trying to cope with this problem are discussed later. But for the moment it seems reasonable to conclude that the technical environment in which university research is carried out is in a poor state, and that real improvement would involve a massive injection of capital.

In terms of pressures on the universities themselves, the effects of obsolescence show themselves most sharply in terms of the setting of priorities. If, in addition to its wage bill it now has to find from its own resources the means to pay for major capital equipment, a university will be forced to choose some research areas to the exclusion of others. The university is thus faced with the unaccustomed problem of choice. Because of the close link between teaching and research, these choices will ultimately reflect in the kinds of courses that a particular university will be able to offer. At risk will be the balance of the curriculum.

Further, because so much scientific research is now capital iptensive (and therefore subject both to the ravages of inflation as well as to the implications of sophistication (1), the pressure on the university will be towards selection of areas of research which can be developed on an incremental, short-term basis, and away from uncertain long-term commitments. There seems a danger that university research will, as a

1) The concept of "sophistication" derives from the view that, as science advances, the techniques and equipment become progressively more complex and hence the cost ot research rises.

Table 2

UNIVERSITY R&D EXPENDITURE

Expenditure in thousand $ US at 1975 prices and exchange rates

	1963	1964	1965	1966	1967	1968	1969
UNITED STATES	0.0	4480902.8	0.0	5203624.4	0.0	6240122.5	0.0
FRANCE	444824.0	548905.0	653927.7	665087.0	741964.6	829718.8	835664.8
GERMANY	708045.6	825902.2	964494.8	1012840.2	1077039.7	1147898.6	1272604.3
JAPAN	796965.9	923095.6	1245216.4	1305535.2	1413017.1	1520094.5	1677883.7
UNITED KINGDOM	226178.9	262243.4	0.0	353549.2	396146.2	419997.8	436302.7
NETHERLANDS	0.0	234263.5	0.0	0.0	0.0	0.0	301279.3
SWEDEN	0.0	0.0	0.0	0.0	116161.4	0.0	0.0
SWITZERLAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BELGIUM	0.0	0.0	0.0	0.0	0.0	0.0	222008.5
CANADA	220100.3	274369.2	319311.4	396626.7	472531.4	510531.3	569298.9
ITALY	194643.8	0.0	225663.8	0.0	292905.3	336504.5	355882.3
DENMARK	0.0	0.0	0.0	0.0	76868.8	0.0	0.0
FINLAND	0.0	0.0	0.0	0.0	0.0	0.0	136690.3
IRELAND	2690.9	0.0	0.0	0.0	5105.5	0.0	6901.7
NORWAY	39624.1	0.0	0.0	69317.6	81231.1	79731.9	83256.3
ICELAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PORTUGAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SPAIN	0.0	0.0	0.0	0.0	3711.1	0.0	5219.7

	1970	1971	1972	1973	1974	1975	1976	1977
UNITED STATES	5806934.8	0.0	5679721.2	5657434.1	5300876.2	5560400.0	5783745.2	5926504.9
FRANCE	873528.4	871083.6	909159.0	907653.5	948754.7	975377.2	995113.5	1006394.1
GERMANY	1568296.9	1849384.3	1926431.9	1968529.9	1921486.1	1869865.8	1847355.3	1817687.2
JAPAN	1929572.4	2133013.6	2268851.9	2403621.9	2569866.5	2830099.3	2944445.0	0.0
UNITED KINGDOM	467972.6	486134.5	506776.8	543058.9	532838.5	503020.3	553610.5	517517.8
NETHERLANDS	338462.2	380575.4	384448.6	375690.8	397587.2	410808.3	435436.7	0.0
SWEDEN	0.0	236788.4	0.0	254182.9	0.0	321210.7	0.0	307197.8
SWITZERLAND	115530.8	121227.7	132494.3	142890.4	157369.0	164258.3	163975.4	0.0
BELGIUM	0.0	252709.4	0.0	246312.5	0.0	215079.0	0.0	0.0
CANADA	607466.9	621920.3	585634.5	5496229.6	550310.7	592000.0	586085.5	597897.1
ITALY	363566.8	365400.5	364281.5	426768.5	399947.5	391907.5	398462.4	0.0
DENMARK	83802.4	0.0	0.0	105239.2	0.0	0.0	0.0	111964.4
FINLAND	0.0	42617.4	0.0	52699.3	0.0	55563.6	0.0	59949.8
IRELAND	0.0	7672.6	0.0	0.0	9426.5	11467.3	0.0	0.0
NORWAY	81210.2	93662.6	106757.2	105642.0	110496.3	119190.2	0.0	150043.7
ICELAND	0.0	1090.3	0.0	1736.7	0.0	2415.2	0.0	2391.9
PORTUGAL	0.0	8856.3	7364.7	0.0	0.0	0.0	7540.9	0.0
SPAIN	6102.2	22287.2	17281.0	15639.8	14311.6	0.0	0.0	0.0

Source: OECD/IUST, 1979.

consequence, become increasingly (and ultimately to a dangerous degree) restricted to the safer and perhaps, even, more trivial questions.

b) Sources of Funds

Quite distinct from the effects of changing overall levels of funding for research documented above, is the effects of changing patterns of funding. In almost all Member countries university research is funded through a variety of sources: funds which can be set aside from the university's own operating budget, from research councils, from private foundations, from mission-oriented government departments and Ministries, and from private industry. Traditionally the relative importance of these different sources has differed between one country and another to a high degree. In some countries almost all university research has been financed from the normal operating budget which the university received from the State. At the other extreme is, for example, Canada, wherein some 40 per cent of all university research is financed by special grants and contracts received from these other sources. (This reflects the joint responsibility of the federal and provincial governments for funding university research). Most OECD countries fall somewhere in between, with external project funds accounting for some 15-20 per cent of total university research expenditure. These different patterns of funding have somewhat different implications.

Because student enrolment continued to increase into the 1970s, countries with a high percentage of research financing via GUF experienced less of a "discontinuity" in development at the beginning of the 1970s than did those with a high proportion of outside financing. Graph 2 shows how this was so. In the Netherlands, for example, problems with the finance of university research have arisen in recent years principally because universities are supposed to deal with growing student enrolments without any real growth in financial resources.

By contrast, universities in those countries in which there is a high proportion of outside funding are much more open to science policy priorities: that is, to external influence upon the kind of research performed in the university. Changes in the policies of the research councils, for example, affect university research more profoundly in those countries in which they are responsible for funding a high proportion of such research.

Table 3 gives some information on patterns of support for research in certain OECD countries. Broadly speaking, there is no evidence for any significant changes in the overall balance of internal funds ("GUF") and external funds through the 1970s. More significant, perhaps, is the structure of the external funding itself, although there is little statistical evidence here. However, it seems to be the case that funds

deriving from research councils are typically growing less rapidly than funds deriving from industry and (above all) mission-oriented government departments. In considering this point it must be borne in mind that whereas research councils have traditionally sought to respond to the changing scientific interests and priorities of the academic community itself (although this is changing, as discussed below) government departments and industry have typically funded research relevant to some practical objective, and thus on rather different criteria. Thus, in Sweden it may be noted that research council funds are believed to be growing less rapidly than those of the other R & D funding agencies. In Germany the budget for research of the Federal Ministry for Research and Technology is growing far more rapidly than that of the German Research Association (DFG) and the Max-Planck Society.

At the same time, it should be noted that in, for example, countries as diverse as Greece and the Netherlands, government policy is now considerably to increase the share of external funds in university research. In Greece the Scientific Research and Technology Agency is in the process of introducing a system of project support (limited to priority areas identified as of importance for the nation) on a scale which is very large by comparison with Greek R & D expenditure. The intention is that ultimately 50 per cent of all public sector R & D (i.e. universities, public research institutions) will be funded on a project rather than an institutional basis. In the Netherlands, the government has recently announced its intention of increasing the share of research council (ZWO) funds in the total funding of university research from the present figure of less than 8 per cent to approximately 16 per cent by 1990. Recent decisions reflect in part the attempt to protect university research against the effects of changing student enrolments, as well as a determination to make university research more relevant to national needs. In Switzerland, too, where the principle of unrestricted admission to the universitites has recently been reaffirmed this is also a priority. In the United Kingdom the current arrangements for the support of university scientific research are being reviewed by a joint working party of the Advisory Board for the Research Councils and the University Grants Committee. This is looking also at how far the arrangements "make for the most effective use of existing and likely future resources".

3. THE DEMAND FOR "RELEVANCE"

Figures showing the broad distribution of university research funds between internal and external sources - and suggesting little change in recent years - do not give a complete picture of current developments.

They say nothing about changes in the criteria on the basis of which projects are selected for support - that is, such data do not reveal the fact that external funds, and particularly research council funds, are increasingly being used as a means of influencing university research.

Furthermore, the proportions themselves are misleading as to the significance of external funds in many kinds of research. This is because estimates of expenditure on university R&D include an element of the costs of the salaries of academic staff - based on that proportion of their time believed to be spent on research. Salaries, in fact, account for the major part of university expenditure, but they are not resources freely available for allocation to research projects. The resources which scientists can spend on the personnel and equipment which their research requires do not include the costs of their own salaries. Moreover, in many countries members of university faculties are paid directly by the state and not by the university itself. Thus the funds received from outside may represent a very much greater proportion of the resources available for distribution according to the needs of research than the proportions given above suggest. On this basis, for example, the University of Konstanz (Germany) estimates that some 56 per cent of its research funds derive from outside sources; in the physics department of the University of Munich the proportion is estimated to be something like 80 per cent. Thus the influence exerted by, or through, outside funds may be greater than has so far appeared to be the case.

Finally, it should be noted that, on the basis of the same logic, such influence may be increasing:

> "In the past, the part of the budget in universities as well as in research institutes devoted to personnel expenditure has always been around 65 per cent, whereas the remaining 35 per cent was used for maintenance, administration, up-keep of the library, and research. In recent years there has been a marked tendency for the share of salaries and wages to grow against a diminishing proportion for the other tasks of the institutions." (1)

Bearing in mind the fact that outside research funds are not only of greater significance for the nature of the research done than their proportion of the total research expenditure suggests, but may be of growing importance, it is necessary to consider the nature of these funds.

As discussed earlier, these outside funds may be regarded as made up of two somewhat distinct elements: the first deriving from the

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1) European Science Foundation. Report 1978. p. 4, 1979.

Table 5

EXTERNAL GRANTS, CONTRACTS AS % TOTAL UNIVERSITY RESEARCH FUNDING (A) AND BY DETAILED SOURCES (B)

I. Canada

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
(A) - External grants, contracts as % total university research funding	41.4	39.9	42.5	44.7	42.0	38.6	38.6	39.7	40.5	40.1
(B) of which:										
- Research Council	21.7	21.5	22.9	25.5	21.3	20.6	21.6	20.3	21.2	21.5
- Federal Government	9.1	9.4	8.5	8.6	8.1	6.0	4.2	5.7	5.8	5.1
- Provincial Governments	7.9	5.0	6.9	8.4	7.6	7.4	8.1	8.2	8.6	8.8
- Other	2.7	4.0	4.3	4.3	5.0	4.6	4.6	4.9	4.9	4.8

II. Finland

	1974	1975	1976
(A) - External grants, contract as % total university research funding	29.1	28.5	24.2
(B) of which:			
- Research Council	16.1	15.8	14.4
- Government	3.6	4.5	3.0
- Other	9.4	7.9	6.8

III. Norway

	1973	1969	1974	1977
(A) - External grants, contracts as % total university research funding	21(16)	22(18)	18(17)	18(15)
(B) of which:				
- Research Councils	13(10)	15(13)	12(11)	11(9)
- Government	1(1)	1(1)	3(3)	3(3)
- Other	7(5)	6(4)	3(3)	3(3)

Note: figures in () include capital expenditure attributed to research.

IV. Netherlands

	1970	1971	1972	1973	1974	1975	1976
(A) - External grants, contracts as % total university research funding	6.2	6.3	9.8	6.7	7.1	7.6	7.4

V. Australia

	1975	1976
(A) - External grants, contracts as % total university research funding	45	43
(B) of which:		
- Earmarked funds of tertiary education Commission	(4)	27
- Research Council	7	6
- Federal and provincial governments	6	6
- Other	4	4

VI. Switzerland

	1975
(A) - External grants, contracts as % total university research funding	26.3
(B) of which:	
- Research Council (FNR)	17.0
- Other	9.3

Source: OECD data.

research councils (such as the American National Science Foundation, the British Science, Medical and other Research Councils, the German Deutsche Forschungsgemeinschaft, etc.) and the second deriving largely from mission-oriented government departments as well as, to some extent, from industry.

The first kind of funds, it will be recalled, have traditionally been awarded on the basis of purely scientific criteria. Research councils have received applications from scientists, submitted them to an appropriate subject committee made up of experts in the field and, depending upon an assessment of their value in scientific terms, awarde the funds sought or not. In the second case it has clearly been conside ations of relevance for some practical objective which has been the major criterion to be assessed. It was suggested earlier that funds of this second kind may be becoming proportionately more important.

But in many OECD countries the criteria on which funds are allocat by research councils have been changing. In place of the traditional, responsive mode of operation, research councils have become more interventionist. This has been so in two distinguishable ways. In the first place, the attempt has been made - in some countries - increasingly to orient university research to broad areas, or to very specific research topics, identified as of national economic or social importance. To som extent this has reflected priorities developed within the research cou cils themselves. In the United Kingdom, for example, the Science Resea Council made known its intention of supporting research in the fields (inter alia) polymer science and technology and control engineering, (although all the Councils have continued to support spontaneous appli cations judged worthy on scientific grounds). In other cases, the rese councils have been invited to stimulate research identified by some sc policy body (as in Finland), or political authority (as in Switzerland Thus, in Finland, the Science Policy Council identified five Priority Areas - public health, living and working conditions, environmental pr tection and promotion of democracy and equality - and gave to the Acad of Finland the task of preparing and implementing detailed research programmes. In Canada, the Natural Sciences and Engineering, Social Sciences and Humanities and Medical Research Councils now have an almos identical task. In France, the CNRS has increasingly concentrated its resources in areas chosen for Actions thématiques sur programme.

It can be seen, therefore, that the identification of research fields has been related to the development of special modes of funding. Modes of funding have been developed in order to bring about collaboration between universities and industry (e.g. in the United Kingdom and France), between disciplines, or to facilitate research requiring large

teams and resources beyond those any university could provide (e.g. Germany). There has, in a sense, been a gradual extension of governmental control over the operating of the research councils and over the distribution of their allocations to fields of science.

Switzerland provides another case. Since 1975 the Fonds National Suisse (FNS) has been required by the Federal Parliament not only to support research projects on a responsive basis (as it had long been doing) but also to develop systematically research areas - so called "national programmes" - identified as of national importance. The areas are chosen by the Confederational Council and the FNS is required to execute them. In this case, traditional considerations of scientific quality in judging an application are to be supplemented by such considerations as the national importance of the problem to be solved, the feasibility of making use of the results, the stimulation of cross-disciplinary and cross-university collaboration. It is intended that these national programmes will come to absorb some 12 per cent of the total budget of the FNS. National programmes already initiated include: prevention of cardio-vascular disease, fundamental problems of the water cycle in Switzerland, energy, and social integration.

These developments in the operation of research councils, and the tendency increasingly to seek to orient university research in line with national science policy priorities, are not universal. Much depends upon the nature of the relationship between the research councils and government, something which differs from one Member country to another and is beyond the scope of this report. Germany and the Netherlands provide rather different examples.

In Germany the Deutsche Forschungsgemeinschaft (DFG) has for some years made use of three quite different modes of research funding. The normal, or responsive, mode of funding, which covers all fields of science, accounts for some 40 per cent of research expenditures by the DFG. The view in Germany is that funds have been sufficient for no good application to be wholly rejected under this scheme. Second, there is the "priority programme" under which fields of research felt to benefit from some national co-ordination of research are supported, generally for a fixed number or years. The idea for a new priority may come from the DFG itself, from university scientists, from a Ministry or from one of the Commissions of the DFG Senate. No political pressure is exerted on the DFG to stimulate one or another line of research, and the view is that priorities have to be determined in the light of the scientific interests of the scientific community itself. When a priority is identified, a group of experts are called together to prepare the outline of a programme, and scientists are then invited to submit applications within the outline.

Finally, there is the "special collaborative programme", in which the purpose is to develop large-scale (often multidisciplinary) research within a specific institution. Universities, with the approval of their Land governments, may apply for such a new programme (Sonderforschungsbereich), but must demonstrate their own commitment to the field in which they are applying, and their intention to develop themselves as major international centres of research in that field. A point which must be stressed is that, unlike in certain other OECD countries, the DFG has not sought to develop these more interventionist modes of research support at the expense of the traditional responsive mode. The share of the normal funding procedure has remained more or less constant (at about 40 per cent) throughout the 1970s. It is, in fact, policy to preserve this proportion: the normal funding mechanism is seen by the DFG as having the crucial advantage of flexibility - of permitting rapid response to a new research opportunity.

As in Germany, one view in The Netherlands (particularly associated with ZWO) is that scientific priorities must in some way emerge from within the scientific community itself. Here, the ZWO has traditionally encouraged the formation of "national working communities". The idea has been that all scientists working in a particular specialism can group themselves into such a community and apply for recognition to the research council. Having proved themselves properly constituted and able and prepared to establish scientific priorities for their field, to evaluate proposals, and impose adequate standards of quality, the working community can be eligible for funds from the Council. In the physical and biomedical sciences increasing numbers of these communities have come into existence over the past years, and now handle much of the research council's role. There has been less such development in the social sciences and humanities. Thus, the ZWO has been less concerned to influence the criteria on which proposals for funds are to be judged than to ensure a more democratic form of decision-making, except insofar as priorities within fields of science have emerged from within the scientific community. In contrast to the situation elsewhere, they have been little influenced by the priorities for national science policy announced by the Minister for Science Policy (which demand much greater effort in research relevant to health, energy and social development, amongst other fields). There has been no earmarking of funds, no priority programmes. Though it seems that there may in the future be some change in this respect, it must be borne in mind that ZWO actually finances a very much smaller proportion of university research than do the majority of equivalent research councils in other OECD countries.

It is clear that in some, but not all, Member countries the attempt is being made, both through research council funds and through the R & D funds of government Ministries, to orient university research towards areas of national importance. Whilst this is undoubtedly a "pressure" upon the university system - in the sense that it is a departure from traditional laisser faire - any evaluation of this tendency must take account of the means by which such priorities are identified.

It is of course perfectly legitimate for governments to seek to secure the assistance of university scientists in developing, through research, means of dealing with pressing national problems. University research systems on the scale on which they now exist in most Member countries are too expensive, and too valuable as resources of expertise, to be ignored in any mobilisation of national resources. The fact that it may prove impossible to find academic scientists prepared to develop research programmes in, say, the field of energy (new sources), conservation, mining engineering, nuclear or solar power, etc.) is not to the credit of the academic community. On the other hand, it is also the case that governments have sometimes been too little aware both of the fact that some pressing issues cannot be directly "solved" through injection of massive resources alone (but require considerable basic research first) and of the need to take some account of the scientific commitments which all good researchers have. Policy-makers may have a tendency to over-define a question: instead of seeking to interest scientists in an area of research, they try to commission research upon a very specific topic within that area. Sometimes the topics so identified have no scientific appeal, either because they are trivial or because they are not amenable to research. Thought must be given not only to the level of generality at which priorities should be expressed (especially where these reflect economic and social more than pure scientific assessments) but also to the mechanisms by which they can be developed, through more general debate. Society, and governments, have a valid claim upon the expertise in the university, but to turn the university into a centre primarily of applied research is an abuse and a misuse of that expertise.

4. THE EFFETS OF CHANGING SOCIAL VALUES

It has not been through these developments in research policy alone that the commitments and concerns of modern societies have affected the universities. Developments in social policy, reflecting changing values, have affected them in other ways too. One important respect in which this has been true is the pressure upon the universities to "democratise" themselves. This has been expressed in part through admission policies,

and in some countries (e.g. Sweden) there has been a major attempt at securing more egalitarian admission. But also, accelerated by the student movement of the late 1960s, this has been expressed through changing processes of decision-making within the universities of a number of OECD countries.

Second, in response to the harsh and uncertain economic climate and the desire to protect workers against its rigours, has been the growth of employment protection legislation.

a) Democratisation

Although it is certainly possible that the democratisation of admissions to higher education might have some impact upon the research function this will not be discussed in detail here. The fact is that such democratisation, at least as regards admission to the traditional university (as distinct from other institutions of higher education) has not proceeded very far in most countries.

So far as the democratisation of decision-making is concerned, there are a number of aspects which have to be borne in mind. The first is the gradual reduction in the traditional authority of the Professor, the Chair-holder, in the many countries which have inherited the traditional German model of the university. In Germany itself there has evolved in recent years a "departmental" structure, involving a greater sharing of authority. This has been hastened by the Hochschulrahmengesetz of 1975; a framework law which individual Länder are required to implement in their own university legislation. In Greece, it is government policy gradually to replace the Chair by a departmental structure, and the new universities being developed in Crete have no Chairs. Accompanying this reduction in the power of the Professor is the second aspect of democratisation: the involvement of a wider range of those studying and working in the university in its decision-making. In the Netherlands, commitment to democratisation in this sense was formalised in the University Administration Reform (WUB) Act of 1970. This law established in all universities a system of Joint Councils (involving academic staff, non-academic staff, and students) at each decision-making level, from that of the university itself down to that of the sub-faculty. However, establishment of committees does not necessarily indicate any major shift in the locus of power. Indeed, the view in many German Universities seems to be that the new administrative structures have had little effect upon the initiation and performance of research. By contrast, in the Netherlands, there is a general view that faculty committees, in which student representatives may be quite influential, have certainly had an effect upon research, particularly in the social sciences, where ideological disputes may develop over research proposals.

b) Employment Protection

In a number of Member countries the development of legislation designed to provide greater security of employment has been one response to the economic situation, and which also reflects changes in social values. However, in a number of countries this legislation is seen as posing problems, or potential problems, for university research. In Germany, for example, legislation now makes it difficult to employ people for more than four years without offering them permanent employment. Thus, even when research funds are available, universities may be reluctant to offer employment for the duration of a long research project to the assistants and technicians which the research needs. The problems is a relatively new one for the universities, and in many countries it appears that they have not yet learned how to deal with it.

c) Bureaucratisation

A further development, which is perhaps not properly regarded as a response to changing social values so much as to changing norms of policy-making, is increasing bureaucratisation. This, too, is a many-faceted development. In part, it has been an accompaniment of the democratisation process. Within the university, democracy has meant that all segments of the academic community must be involved in decision-making and this is typically done through systems of committees. Many scientists complain bitterly about the time taken up in attending such committees. There has also been, perhaps more particularly in North America, the growth of a central administration within the universities - with its cadre of professional administrators - to handle (amongst other things) the external research contracts upon which universities have come so much to rely. (It should be pointed out that in many countries in Europe this particular tendency is being strenuously resisted. In one large German university, for example, success in holding down the size of the central administration is a proud boast.)

The bureaucratisation of science has not been wholly due to the university. As the funds available from government for research expanded through the 1950s and 1960s, the system of committees to which responsibility for allocating these funds was largely delegated, expanded too. As the funds contracted, the committees largely remained; reflecting in some way the "structure" of science. However, the more recent growth of interest in making scientific research "relevant", has added to these committees others with responsibilities determined not by the structure of science but by the structure of government decision-making. Scientists complain that the amount of effort which must now go into the preparation of an application for research funds is far too great. The same

development, and the gradual subordination of research policy not only to governmental priorities, but to traditional governmental modes of operating, has led to the new emphasis upon accountability. In several countries, government departments now take a much more detailed interest in the progress of the research they commission and require far more detailed evidence as to the expenditure of the funds.

Accountability has become a major worry of scientists, particularly in the United States, where it has been suggested that over the next five years the health of academic science is threatened as much by the accumulation of non-monetary impediments to research as by prospective shortages of funds. Increasingly restrictive terms and conditions attaching to Federal funds, the growth in requirements for record-keeping and reporting, the increasing complexity of procedures for applying for funds, the time and effort required to administer Federal regulations, and the burdens of these regulations, force a large-scale diversion of effort from research, and constitute a hidden drag on the efficiency of academic science.

To be sure, these developments have a certain legitimacy and cannot be viewed in purely negative terms. There is a broad consensus in many countries that certain kinds of research require a degree of regulation, if only because of the dangers (for example to health) which may be entailed by certain kinds of experiments (e.g. genetic manipulation) if these are not carried out only under approved safety conditions. Also, machinery established for the purpose of formally establishing research priorities and negotiating with scientists who may then carry out the work can, in theory at least, provide a means of feedback. It should not be forgotten that such a channel of communication between researchers and "customers" can have utility in ensuring diffusion of results, if properly used. Nevertheless, because the benefits of these developments receive relatively greater stress by governments, it is the negative effects which require emphasis here.

Chapter II

RESPONSES OF THE ACADEMIC SYSTEM

Four types of constraint have been identified which, acting singly or in one or another combination, appear to be creating symptoms of stress within the universities of many Member countries. As a consequence of this stress the universities may be said to be experiencing a certain "malaise". In particular, there is widespread concern at what, in many cases, is an all too apparent lack of innovativeness, difficulty in starting research under desirable conditions of staffing and instrumentation, and pressure towards performance of research which may not seem to be of the highest scientific importance. The principal constraints acting on the universities can thus be summed up as:

i) fluctuations in student enrolments;
ii) slowdown in the growth of financial resources and, perhaps more important, a change in the balance between the various sources of research funds;
iii) government pressure for "socially relevant" research;
iv) the effects of changing social values: "democratisation", employment protection and, not unrelated, growth of bureaucratisation.

Every university has had to face one or more of these constraints at some time in the past decade. Each has responded in a fashion dependent upon its own specific and local circumstances - and with greater or lesser difficulty. If often seems as though the newer universities founded on the traditional model (which of course many were not) are finding adjustment to changing circumstances more difficult than the older-established (and perhaps inherently and almost unshakably conservative) ones. So, not all universities have responded in the same way: some have been more innovative than others in their adversity.

No attempt will be made to catalogue the variety of responses in any exhaustive fashion, but rather to highlight what seem to be the more significant responses, and to show that in some cases determination has led to practical coping strategies which deserve wider discussion and which may have relevance for a number of Member countries. These responses will be considered under four headings:

i) new modes of distributing resources;
ii) separation of teaching and research;
iii) stratification of institutions and staff;
iv) recruitment and mobility.

1. THE DISTRIBUTION OF RESOURCES

The combination of declining budgets and fluctuating student numbers places the universities in a difficult, but far from unique position. Many organisations have to adjust to declining availability of resources and, under present economic circumstances, many other than universities will continue to have to do so. It can reasonably be claimed that, in many areas of activity, adaptability (involving structural change, change in attitudes of staff, etc.) is essential for success or even survival. This is probably true of industrial organisations. So far as the universities are concerned, however, it would be argued by many that "over-adaptation" is a danger: that universities (whatever their real or potential contribution to economic growth, to manpower production, etc.) are also repositories of knowledge, of tradition, of scholarship. The danger is that something quite unique, quite irreplaceable, might be lost. This perspective must at least be borne in mind.

The first and perhaps primary consequence of the slowdown in university expansion, then, is to force serious consideration of priorities. That each university should possess a research capability over the whole range of science, technology and scholarship is an ideal to which only a few favoured institutions can aspire, and it is to be expected that there will be continuing pressure for further institutional specialisation.

University resources for research come through three channels: government, industry, and the public non-profit sector (which includes the Foundations). The government sector may be split into three principal sources of funds: those contributing to the university's general funds and which support educational objectives but part of which is used for research; funds from the research councils; and funds from mission-oriented agencies.

For the purpose of discussing new modes of distributing resources it will be useful if, first, a general type or typical procedure is described. This for two reasons: (i) it corresponds reasonably well to the system which has operated during the expansion phase of the 1960s and is to a large extent still operative, and (ii) with such a model it is easier to understand some of the innovations which have been made,

since in many respects they are departures from it rather than complete re-organisations of the resource distributing system.

The general type is simple enough. Its principle characteristic is that it leaves the question of research priorities entirely to the scientific community. This occurs in two ways: (i) General funds are passed from central government to the universities. Allocation of these resources takes place within the university at different levels. As a consequence, the research priorities are those arrived at via this bargaining process. (ii) All other types of funds, whether from research councils or mission-oriented agencies, the PNP sector or industry, depend upon individual scientists or teams of scientists applying for funds, grants, etc. Therefore, as with (i) research priorities reflect the interests (and to a large degree the enterprise) of individual scientists.

The principal consequence of this mode of resource allocation, acting over many years, is that in universities research has grown in a haphazard manner and, more importantly, is very sensitive to changes in the flows of these resources and to the persistence of enthusiasm among research staff. Unfortunately, changes in the availability of funds all too easily seem to dampen this crucial spirit of enterprise which, linked with decline in morale, contributes significantly to the "malaise" referred to earlier.

It is not easy to see what alternatives exist. The tendancies identified are likely to remain significant. More careful husbanding of resources - i.e. controls on the growth of public expenditure - is in the present economic context a policy more likely to be widely adopted than to be abandoned, and university budgets are liable to be squeezed still further. Mission-oriented government departments, and to some extent the research councils are likely to continue to press for "socially relevant research", and there is a real risk that in some Member countries universities will find themselves performing short-term applied research rather than the strategic research related to social and industrial objectives. It will be argued in the final chapter of this report that it is precisely this strategic research which represents the major contribution which universities can, and should, make to society's attempt at coping with the problems with which it is confronted. However, unless there is a significant change in the processes of allocating research resources to universities, these resources will be monopolised by those scientists who feel prepared to take up the topics being "put out to tender". They may not always be the best scientists.

What room for innovation here? In general there is a paucity of ideas. This lack stems principally from an insufficient understanding

of the nature of scientific and technological activities and, therefore, a fear of interfering with them to their detriment. A significant attempt to come to grips with the dynamics of scientific and technological activities and their relationships to the relevant communities of active researchers may be illustrated by the approach of The Netherlands to the problems of distributing resources for research to universities.

In this country, an attempt has been made to redesign the processes by which general university funds (called "first flow of funds") and external research funds (called "second flow of funds") flow into university research. In respect of first flow of funds, a government memorandum of 1975 proposed that, in order to protect the research elements of the university's activities, the research and teaching elements of the university's normal operating funds should be "decoupled". Certain of the proposals made are still under discussion, but changes have already been made. In a subsequent (1979) Memorandum the government's intentions were spelled out in more detail. It is now the government's policy to make a clear division within what are at present normal universities' operating funds. There will be one subflow, corresponding to present GUF, and one subflow called "conditional funding". To obtain funds from the Ministry of Education and Science via this second subflow, the university in question will be required to agree a research plan with the Minister. Conditional financing will be introduced step by step, in a few fields of science, from 1982. The budget of the research council (ZWO) will be increased. It is intended that by 1990 the proportions of university research funds deriving from these three flows will be: direct finance (present GUF) 50 per cent; conditional financing 34 per cent; and ZWO 16 per cent. At the same time as the ZWO contribution is increased, that organisation will be required gradually to become more interventionist, but this implies that universities will have to acquire a competence in the establishment of priorities and the planning of their own research efforts. Some progress in this direction has already been made.

There is already a tendency in a number of universities towards allocation of resources less on the basis of student numbers and more towards a "project based" approach. In the University of Leiden, for example, the university's research policy is designed to "stimulate highly productive long-term projects". A gradually increasing share of its research budget is being set aside for support on a project basis, and faculties are being encouraged to present their research projects for support in this way in order to avoid a decline in their research resources. Proposals are evaluated in the light of peer-group assessments, plus such quantitative indicators as citations. Similarly, to

stimulate and protect high-quality research, the University of Utrecht has established a Research Committee which may dispose of a number of temporary research posts. Clearly, the government's current plans will lead to extension and formalisation of this planning process. Probably it will lead to extension of the planning to cover access to, and research funded by, external sources (notably ZWO), which at present is not the case.

In Germany, by contrast, the idea that any meaningful distinction could be made between universities' teaching and research funds is regarded sceptically. Central control in the German universities tends to be weak, with authority largely vested in the individual faculty or department. Few universities make any overall attempt at planning research priorities, and even as major a development as Sonderforschungsbereich may represent more or less the initiative of a single faculty.

The German Wissenschaftsrat (Science Council) considers that current circumstances require that universities do move towards a system of institutional priorities and support for chosen fields of excellence. The system which it wishes to see adopted, and recommends, exists really only in two German universities: the Free University of Berlin and the University of Konstanz. In Konstanz, for example, the university's budget from the Land government is divided into a teaching and a research element, and the research element is put at the disposal of the University's Research Committee. Each year, members of the faculty apply, on a standard form, for research funds. The Research Committee evaluates them principally on the basis of scientific merit, although special weight attaches to proposals for multi-disciplinary work, and some attention is paid to the balance of funds between faculties. Although some members of the university are unenthusiastic about the system, and regard it as excessively bureaucratic and lacking the expertise necessary for proper peer-group judgement, it seems to work reasonably well. The University of Konstanz has maintained its commitment to research and receives a very high volume of outside research funds for its size. As in the Netherlands, the Research Committee here has little control over applications for outside funds, although its formal approval is required. It must be said, however, that there seems relatively little general enthusiasm for a system of this kind: the implications for traditional German academic values are very substantial.

In the Swiss universities, also, a mechanism for university research planning exists, through the university (and Federal Polytechnic) Research Commissions. Broadly speaking, these commissions form part of the authority structure of the Research Council (Fonds national) of the Confederation. They have the tasks of (i) allocating fellowships to young scientists within their institutions, and (ii) providing information to

the Fonds national to be used in evaluating applications from members of the faculty (on such matters as availability of instruments). In the Federal Polytechnic institutions the Research Commissions have a larger task. In Zurich for instance, they actually provide an assessment of the quality of each application submitted by colleagues to the Research Council. In both Zurich and Lausanne the Research Commissions advise on the distribution of a research element of the institutions' own budget, which is allocated on a project-application basis. Extension of this system to Switzerland's (Cantonal) universities is under discussion.

The establishment of university research policies is a response both to the fear of erosion of research which can be funded from internal (GUF) funds, and to a fear of the consequences of a growing reliance upon external funds allocated without proper regard to the university itself as an institution, and only in the interests of very broad national policy objectives. It is a development of considerable importance. In Germany, the Wissenschaftsrat has sought to stimulate research planning more or less as now practiced in Konstanz, but there has been considerable resistance to what is a clear departure from the traditional authority of the Professor. In Finland, too, the Ministry of Education has recently attempted to encourage research planning at the university level, but here also the universities have found it difficult because so unaccustomed a task and in conflict with traditional authority structure. Despite the many setbacks which this development has encountered, it is nevertheless one of few innovative and positive attempts at coming to terms with, adapting to, the changing situation of university research.

Such planning is not necessarily dependent upon the attempt to separate the research and teaching elements of the university's own budget. In cases where significant proportions of research are funded from external sources, planning may begin with this project finance - as in Switzerland. Yet, as the Netherlands case shows, where the majority of research is funded from "own" funds, then the distinction may be a necessary one. It is of course a difficult one. Many university people not only believe that this separation is difficult (or impossible) but should be avoided. There is a feeling that if the research component of their budgets does become visible there will then be a danger of further government control or cutting of research.

2. THE SEPARATION OF RESEARCH FROM TEACHING

Universities everywhere have tended to hold tenaciously to the view that teaching and research are inseparable. This is not to say that any fundamental value conflict over the changing budgetary procedures being

introduced in the Netherlands was to have been anticipated. The ideological commitment is to the symbiotic relationship of high-quality research and high-quality teaching. This has sometimes been taken to mean that the same individual must divide his (or her) time between the two activities, or sometimes that the two must be pursued in the same institution, by colleagues in touch with each other. There have been dire warnings as to what would happen if the two functions were separated...

i) By providing different professional routes within the university, staff would become stratified into teachers and researchers, and from there into first and second class citizens. (1)

ii) Because undergraduate teaching is an important stimulus for future scientists the separation of teaching and research would lead to a falling-off in the numbers choosing to enter post-graduate work, and that eventually this number would fall below that needed to maintain a base-level capability in a given discipline. In the shorter term the quality of all teaching would suffer from being cut off from the fructifying effects of original research.

iii) Separation of teaching and research leads to a parallel institutional separation into teaching centres (which may be centres of excellence in undergraduate teaching) and research institutes - although all disciplines would not be affected equally be such developments.

iv) The research institutes would become increasingly dependent upon short-time swings in government policy for R & D. Whilst such responsiveness is not unequivocally a bad thing, in countries where the bulk of basic research is funded by government (most countries) the independence of the university is to some extent threatened.

Recent Swedish experience seems to bear out these fears. Interestingly, it was the student expansion of the 1960s which started a process which led to the institutional separation of teaching and research in Sweden. During this period, the expansion of demand was met by the creation of the post of "university lecturer" as a full-time, tenured, undergraduate teacher. University lecturers were expected to follow

1) This fear relates to the effects of separation of research careers from teaching careers not, as is the case already in many national systems, of the effects of separating research (careers) from teaching-plus-research careers. Concern is occasionally voiced on behalf of professional researchers in universities wherein no research career exists. But this is a separate (although increasingly important) issue.

developments in their respective fields but were not required to carry out research. On the other hand, Professors, "docents" and research assistants (an appointment which requires the PhD degree) were to be concerned mainly with postgraduate education and research.

This separation between the two types of academic posts has led not only to a distinction within departments (aggravated by the different organisation of undergraduate and postgraduate education) but also to different career paths within the university. For example, a university lecturer is a tenured position, while on the research side only professors have tenure; docents and research assistants do not. After completing a PhD, then, one can choose, depending of course upon the availability of positions, between a teaching appointment (lectureship) or a research appointment via the route research assistant-docent-professor.

The research line involves far more uncertainty because research assistants and docents may hold their posts only for a maximum of six years. It must be added, however, that owing to employment protection laws it is rather difficult to dismiss non-tenured staff. Apart from this, there is the fact that the splitting of functions in this way makes the research function particularly susceptible to the pressures arising from outside sources of funding.

As a result, Sweden is now trying to restore, at least in part, a close connection between teaching and research. A recent government commission has reported (Spring 1980) that a new staff structure should be established in the university, including three levels: professors; docents (the former university lecturers and former docents); and research assistants (forskarassistenter). All positions will be tenured and at each level incumbents will be expected to engage in teaching and research. The mixture will be decided mainly at the local level and not, as now, centrally. At the same time, a new step to permit an element of flexibility in research is proposed. The Faculty Boards would have at their disposal a "pool" of research time. Any tenured member of staff would be able to apply to the Board for a certain time for research above that which he would otherwise have, and which would be paid for out of this pool. In other words, this mechanism would require Faculty Boards to perform a role in the setting of research priorities (akin to that described earlier as now operating in some German, Netherlands and Swiss universities). The Faculty Boards would also be able to create temporary research positions out of this pool.

A second problem for the Swedish universities arises from the decision to organise R & D around sectoral goals - that is, to emphasize the practical utilisation of research. But Sweden, unlike the United

Kingdom, where the post-Rothschild reorganisation had a similar purpose in applied areas, lacks a substantial government research capability: most research capacity is concentrated within the universities. Because of the separation of teaching from research, the universities were able readily to respond to the government's policy of "sectorisation", with the caveat that some disciplines were more able than others. The fact is that some scientific disciplines are inherently more able to adjust their goals in this way than are others: engineering more than the social sciences for example. Their organisation reflects this fact. Thus, this policy of emphasizing research of relevance to practical Agency goals has had the effect of favouring some disciplines at the expense of others, with implications not at all easy to forsee, and certainly unforseen.

3. STRATIFICATION OF INSTITUTIONS AND STAFF

The Swedish example indicates some of the effects of a stratification of staff within an academic institution. Difficulties derive from the traditional weight attached to research in promotion, and from the fact that research commitment has come to be the major determinant of both individual and institutional status within higher education. The point is made by Ben-David in his historical analysis of the development of higher education in the United States (1):

> "If, in the period beginning in the 1860s, there was a single scale of prestige for universities that derived from the general social and cultural standing of their students and teachers, then at the end of this period, in the 1930s, there were two successful scales: the old one ... and a new one derived from excellence in research. In some places the two scales tended to coalesce ... Since World War II, there has been a growing ascendency of the prestige based on research ..."

In fact, if the effects of ranking American Institutions on the basis of commitment to research are compared with a ranking on the basis of how selective the institutions are, then Ben-David's view that there are in the United States two quite distinct forms of stratification - with a few institutions doing well in each - seems to be borne out. On both sets of criteria the same three Universities come out top: MIT, Harvard, and Stanford. But then, research commitment brings in Columbia, Michigan, Berkeley, Illinois, etc. - whereas ranking by selectivity (i.e. how hard it is for an intending student to gain admission) brings

1) J. Ben-David, American Higher Education (McGraw Hill, 1972).

in Caltech and a number of famous Liberal Arts Colleges: Swarthmore, Rice, Reed, Amherst, etc.

The situation is not the same in all countries: the most notable exception being France wherein it is the "Grandes Ecoles" - highly selective but engaged in research to relatively slight extent - which retain highest prestige. In others there is no "traditional" system of status based upon selectivity or the social class of students: indeed, this is the case in the majority of OECD Member countries. For this majority it may be concluded that a system of status based upon research is emerging unchallenged by older competing hierarchies.

Research resources are concentrated in small, elite segments of higher education systems in many countries. It may also be the case that significant research will be increasingly concentrated - or limited - if policies of concentration of resources in the interests of research excellence actually take effect.

Data at present available show (i) that there is indeed a high degree of concentration of research expenditure, and (ii) that there seems at present to be no increase in the extent of this concentration. The first of these points may be illustrated by reference to Canada, where out of nearly 50 universities only 10 receive between them over 50 per cent of research council funds. In the United States, in 1974, 60 per cent of basic research expenditure was concentrated in only 40 of the nation's 2,000 + post-secondary educational institutions. In view of the extent to which research funding bodies in a number of countries have expressed their intention of concentrating resources in a limited number of institutions - in order to ensure more "effective" research - it is perhaps surprising that data reveal no increase in the extent of this concentration. In the United Kingdom, for example, where the Science Research Council has long been committed to such a policy, data actually suggest a somewhat wider spread of resources than was previously the case.

It must be recognised that there were in the past certain factors operating which will have made concentration more difficult. In Australia and Finland, for example, the special claims of new universities still being established around the early 1970s were recognised, and the attempt to build-up research within them received special support. In the United Kingdom the polytechnics, regarded primarily as teaching institutions (though seen also as suitable establishments to undertake a certain amount of industry-linked research, particularly research sponsored by local firms), also attracted sympathetic consideration through special research council machinery. In the United States, the NSF operated a special programme of institutional development for new and second-tier

institutions. It seems clear that such considerations will have less weight in the near future than they did even in the mid-1970s.

It is not easy to be certain of the effects of any increase in the extent of stratification between universities (or within the higher educational system in general in those countries where clearly distinct types of institutions are to be found). A decline in the morale of those working in institutions in which research expenditure and commitment is visibly declining seems one likely effect. It may be postulated that the motivation to seek to move towards better endowed institutions offering greater research opportunities will become even greater than it is or has been. Yet, for reasons discussed in the next section, the possibilities for change of job within the higher education system are already diminishing. The situation - where the means to realise career goals in research, to act in accordance with the values absorbed in scientific training and deeply held throughout the scientific career, are simply not available - corresponds to the classic sociological conception of anomie. All this, taken together with the other effects of an ageing academic community, suggests that falling morale, disillusionment, perhaps a "turning away" from scientific satisfactions and rewards towards quite other (e.g., leisure) pursuits (a classic "coping strategy"), may be the most serious of all the consequences of the current situation.

It is of course quite consistent with the evidence so far available that only with respect to the performance of basic research will this growing concentration of effort be found, since funds for more applied research are in many countries increasingly available. A plausible scenario is of a university system largely given over to short-term applied research, with pure scientific research severely restricted to a few traditional institutions.

4. RECRUITMENT AND MOBILITY

Of the various effects which the rapid expansion of university enrolments in the 1960s followed by stagnation has had, perhaps the most widespread has been the ageing of university staff. Rapid and substantial recruitment of new, young faculty members in the 1960s, followed by a virtual end to recruitment in the late 1970s has resulted in a teaching body growing old together. One effect of this was raised earlier in this report: as the faculty ages so its salary costs rise as a result of increments in pay. It is this fact, in part, which explains the diminishing proportion of university funds available for research purposes. Studies by national authorities, and by the European Science Foundation, show how in many countries age distribution of university staff demonstrates

a high peak around the age of 35-45. This is particularly apparent for France, Germany, the United Kingdom, less so for Italy and Sweden, least of all for Switzerland.(1)

The effects of this ageing are complex. On the one hand it is sometimes argued that scientific creativity falls as a scientist ages. Perhaps of greater importance here is the effect of ageing upon a research group. Work by Pelz and Andrews suggest that as a research groupe ages together (without infusion of new personnel) its scientific productivity begins to decline after a relatively small number or years.(2) Smith, looking at research groups in a large petroleum engineering company, reached somewhat different conclusions.(3) The direct effects of ageing upon productivity are not clear, though a negative influence seems possible.

There are other less direct effects which have to be considered. Thus, ageing has to be seen as interacting with the employment situation in research generally. The lack of posts, combined with the greater reluctance of older people to move to new posts, means that the mobility of scientists has been greatly reduced. This lack of mobility is in itself a matter of serious concern, not least because of the importance of mobility for interchange of ideas, for innovation. The lack of new posts discourages many from undertaking postgraduate research, which is seen as the preparation for a university career which will be unavailable. There is a real fear (e.g. in Germany) that it is the most able who are most likely to reject the university, and that hence the average quality of university research will gradually decline. Morale among those who are teaching and carrying out research in the universities is lowered by the lack of promotion possibilities. This, too, will reduce the quality and innovativeness of university research, and make the initiation of new lines of research, all the more difficult.

If the current age profile is projected into the future, and in the absence of major policy initiatives, the situation appears still more serious. By the mid-1990s the great number of university scientists who are today 35-45 will be aged 50-60 and be coming up towards retirement. In many countries this is a time when demographic factors make an increase in enrolments likely. It is all too probable that there will then take place a rapid recruitment of new academic staff - to cope both with expansion and with retirement - from the (by then) severely diminished

1) European Science Foundation: unpublished results of a current study on mobility and ageing.

2) D.C. Pelz and F.M. Andrews, Scientists in Organisations: Productive Climates for Research and Development (NY, 1966).

3) C.G. Smith, "Ageing of R & D Groups: A Reconsideration", Human Relations, 1970.

pool of new PhDs. As happened in the 1960s, the urgency of this demand may lead to the recruitment of many who are simply of inadequate calibre.

Relatively few countries have recognised the serious implications (both short- and long-term) of the current situation and taken steps to deal with it. One concrete proposal is the "Heisenberg Programme" put forward by the Presidents of the German Research Organisations. According to a decision taken on 7th November 1977 by the Heads of Government of the Federation and the Länder, up to 150 young scientists each year (i.e. a total of 750 persons over a period of 5 years) are to be awarded grants. The amounts of the grant will be oriented to the remuneration of comparable scientists working in universities. The young scientists receiving such grants are to be given the opportunity to carry out research for an initial period of three years, but with the possibility of a two year extension. Applicants must be qualified university lecturers, or furnish evidence of comparable academic qualifications. The programme will be executed via the German Research Society (DFG). It covers all fields of science. In fact, this scheme of temporary job creation has been somewhat controversial, partly on account of its acknowledgedly elitist character. Moreover, although a number of scholars have been appointed, it is proving difficult to find a sufficient number of young scientists of high calibre. There is a feeling that the reluctance of young scientists to wish to compete for these posts is due to the temporary nature of the appointments. The demand for security is such that a permanent post offering far less in the way of research opportunity is nevertheless seen as more attractive to young German scientists.

In other countries measures are being discussed but little has been done. Measures under discussion in Canada, for example, range from the creation of new posts for young scientists, through "work sharing", to the attempt to increase the demand for higher education, and in May, 1980, the Natural Science and Engineering Research Council announced a programme to expand career opportunities for promising researchers within these fields.

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This chapter has outlined some of the "responses" of the university research system to the changing demands and the growing pressures acting upon it. What is striking, and gives cause for concern, is the meagre number of innovative policies which have emerged. The development of institutional research policies in The Netherlands and in a few Swiss and German institutions may be a guide to what might be done to cope

with certain of these pressures. Yet it is a development which has not diffused widely and has encountered serious resistance.

The belief in The Netherlands that research priorities at the national level have to be evolved with the co-operation, and with due consideration for the interests, of the scientific community is worthy of serious debate. Yet, in many Member countries national science policy bodies, or research funding bodies, continue to formulate priorities "in the national interest" which have no reference to what scientists themselves regard as worthy of study. Starving the academic research community into accepting funds for <u>any</u> project is no real solution. Only one or two countries have begun to develop policies for overcoming the multiple dangers of a scientific population growing older, more immobile, and more demoralised year by year. The catalogue of innovations is all too slim, and hardly seems adequate by comparison with the magnitude and generality of the problems besetting the university research systems of Member countries.

Chapter III

UNIVERSITY RESEARCH AND THE CHALLENGES OF THE FUTURE

It has already been suggested that important changes in the traditional structure and functioning of the universities have been brought about by the social and political developments of the last decade or so, and the new demands placed upon them. It now remains to try to assess the implications of these changes for governments, policy-makers and the universities themselves. What must be done so that the universities, particularly through the performance of research, can continue to contribute to the solutions of the manifold problems confronting society? It is within this perspective that, in the last analysis, the particular constraints which have been acting on the universities must be evaluated and the main options facing governments explored. There is no implication that all, or even most, of these changes have affected the universities in an adverse way, but rather that if these changes continue the universities would not in the 1990s be the institutions they were in the 1960s. It is most important for policy-makers to appreciate this when they seek the collaboration of the universities in social problem solving.

1. THE RESEARCH CAPABILITY OF THE UNIVERSITIES

It is clear from the information presented throughout this report that is not possible to identify any single or unique set of changes in either the structure or operation of the university research system. On the contrary, and not surprisingly, major differences between Member countries have been shown to exist. Nonetheless, it is possible to identify certain tendencies common to most countries which are likely to affect the ability of the universities to meet the demands which seem likely to be placed upon them in the near future.

One essential point to be borne in mind is that almost all the additional demands places upon the universities have affected their ability to perform their "traditional" functions: that is to carry out both teaching and research in all or many of the more important branches of learning, at both undergraduate and postgraduate levels. Now, it may

be that the current economic and social climate will no longer support this ideal; but governments must be aware of the possible consequences if this "comprehensive" service is progressively dismantled in a piecemeal fashion.

Some of these consequences are already apparent from the information and impressions gathered for this report. The summary which follows does not describe any one Member country, but rather seeks to draw attention to certain trends, to bring to light the most salient points of concern or uncertainty, and to try to spell out some of the choices which, policy-makers will have to face in the very near future.

a) The changing role of research within the university

A number of distinct developments can be identified which serve in some way to constrain the context in which research is carried out within the university and thus affect the ability of the university to fulfil its other functions. The overall effect is to reduce the ability of the university to provide a comprehensive service.

One illustration of this attempt to confine the function of research to a specific part of the university is the policy recently advocated in Sweden of making a clear operating distinction between teaching and research. To this end, the total university budget is divided into two parts - one for undergraduate education and the other for postgraduate education and research. The primary purpose of this separation is said to be to break the direct financial influence of varying undergraduate enrolments on university research and, consequently, to give research something of a stable, independent existence. However, in addition to the budgetary dimension, there is also a structural dimension; the existence of two career paths within the university - one for teaching and one for research. This policy (which, as already mentioned, seems to have given rise to some second thoughts) makes it a formal requirement for professors and their assistants to carry out research. Lecturers, on the other hand, are considered primarily as university teachers and although not prevented from doing research, they are not required to do so. If it turns out that the teaching route is a less uncertain one towards tenure, then it could be a more attractive option for the brightest academics - particularly if the growth of new academic posts continues to stagnate. (1)

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1) There is, of course, the converse situation aptly described as the "publish or perish syndrome", which can also lead to the separating of teaching and research activities. The situation in this respect of the American universities has been the subject of some criticism.

A similar objective towards the separation of teaching and research is being pursued in the Netherlands, implemented through budgetary procedures. Here, also, the manner in which the Netherlands universities are trying to "decouple" teaching and research could lead in the same direction: to both the functional and social separation of these activities.

Another idea which has gained some currency is to make universities responsible for their own research policies. There is, of course, a good deal to be said for the universities being able to establish their own research priorities and allocating their research income in response to project applications judged on their merits, as is done by research councils; but there is a danger that in all but the biggest and most prestigious universities this might lead to a situation in which the average university would be in a position to carry out significant research only in a restricted number of fields, involving only a small proportion of the academic staff. Universities have not been accustomed to making decisions of this kind, and it is not a remote possibility that decisions about real research priorities would not be taken, but that research activity would drop in quality and quantity consequent upon a policy where everyone gets a small amount of available resources.

A third trend concerns concentration of resources, that is to say, the proportion of total resources awarded by research councils to a certain proportion of the total number of universities in a given country.

It may seem somewhat surprising that statistical data for a number of countries show little change in concentration of research resources: that is, in the shares of the top few universities in all the funds available for research projects. In a context in which resources are declining, this could mean that many universities are functioning near or, more probably, below the threshold level required to interact successfully with developments in the various disciplines.

Insofar as the intention of research councils is to make research support as effective as possible, the outcome of continuing policies of concentration will undoubtedly lead to a sharper stratification of the higher education system. The legacy of the expansionary period (in which the claims of new, second-tier, or non-university institutions to research funds were recognised) will be of declining significance as research-effectiveness comes to dominate policy formulation. In this situation, there is a strong likelihood that the traditional universities will predominate.

Whilst it is true that the idea of the university developing a problem-orientated approach, in which research is used as a pedagogic

device, can represent a countervailing tendency (1), this notion seems unlikely to develop beyond a few institutions, some of which may even be abandoning it.

The implications for policy-makers of these trends bear on the notion and desirability of a "comprehensive" university service. Consideration will have to be given to the implications for higher education generally, but also for national research capability, of creating universities in which research is performed separately from teaching; is performed only in certain restricted areas of scientific endeavour; or in some universities is not performed at all.

b) Decreasing flexibility

A separate set of trends suggest that the universities in some countries may be becoming increasingly inflexible in research performance: that is, unable to respond to the imperatives for change, whether these arise inside or outside a scientific discipline. Insofar as institutions specialise in one or another area of research (as the above analysis suggests may be happening in some countries) it may become not only more difficult to alter the balance of research between fields, but also to promote interdisciplinary collaboration when centres of expertise are located in different institutional or geographical locations.

The much-discussed topic of the ageing of the academic community is obviously related to the implications of reduced flexibility. The previous analysis has shown that this a general problem arising from the rapid increase in student enrolments in the 1960s. It is the levelling-off in demand for university education (combined with economies in public expenditure) that has led to stagnation in the recruitment of academic staff. This has two major kinds of implications for the flexibility of research performance.

In the first place, the lack of recruitment which to some extent characterises all universities in the OECD area, has reduced inter-institutional mobility to nearly zero. As a result, the creation of new research areas which depend critically upon the availability of new appointments has become increasingly difficult. This difficulty is rendered all the more acute in those countries where research training is still dependent upon obtaining a university appointment (usually as an assistant) because few of these posts now become vacant and fewer still are being created.

In the second place, the number of major intellectual changes possible within a given career or professional life-time is trictly

1) For example see the University of Wisconsin at Green Bay, United States, and Lancaster University, England.

limited. The longer an academic stays within a given research tradition, the more difficult it is to move into a significantly different tradition. The academic community appears to be increasingly reluctant to face the risks involved in a radical shift of research interests. Quite apart from the intrinsic intellectual difficulty involved in such a transition there are considerable social and physchological barriers to this type of reorientation, which seem to increase with age. The overall result is that the distribution of scientific interests within any given institution tends to become more rigid and thereby reduces the likelihood that a new pattern of intellectual interests will emerge.

A further element of inflexibility is introduced by the growth of legislation in relation to employment protection. Legislation introduced for the benefit of workers generally has had important effects on all aspects of university life. It may be that universities are becoming reluctant to accept research assistants paid from external project grants because they may later lay claim to a permanent position. This applies also to technicians. As a result it becomes difficult to alter the distribution of technical assistance and difficult to hire technicians on contract. This creates yet another barrier to any significant shift in research effort between fields.

If the university research system is to be refashioned in a piecemeal manner in order to create various forms of institutional specialisation, as the general economic climate would appear to necessitate and the policies of some research councils seem to imply, then policy-makers must be aware that if the balance of the university research effort will be difficult to alter when it operates across a wide range of disciplines and is able to recruit new members of staff, them the realistic possibilities for change are much reduced if the universities are already confined to certain specialized branches of science, and staff mobility has been reduced to a mere trickle. This situation will be exacerbated if it continues to be difficult to recruit new, young staff, either because of a contraction of higher education generally or because of more specific social developments in relation to employment protection legislation. The research councils have a powerful innovative role to fulfil in this respect. Through their ability to allocate resources, they should be in a good position to encourage institutions and groups of researchers to combine their resources and talents in developing new areas of research interest.

c) Post-graduate training

One of the functions of post-graduate training is to provide a scientific elite for industry, government and the universities; an elite

which will sustain the process of technological innovation and provide for future generations of academic teachers and scientists.

In several OECD countries a decline in the numbers of students taking post-graduate degrees appears to be taking place. Some qualification of this general conclusion is necessary, for two reasons. Firstly, the structure of postgraduate training varies between countries and between fields within one country. And secondly, the data that is available in most countries pertaining to the output of postgraduate students is seriously deficient. These two qualifications are, of course, related insofar as the absence of formal postgraduate training programmes such as those which exist in the United States and Canada make it more difficult to obtain both input and output data over a time span sufficiently long to observe trends.

Nevertheless, data on the output of PhDs for certain countries together with the impressions gained during country visits, support the general conclusion that there is a general decline in the numbers of postgraduates being trained. Although there are many complications involved in interpreting such output data, it seems reasonable to argue that the number of doctorates awarded per year gives an indication of the amount of research being carried out in the universities (assuming, of course the existence of postgraduate research programmes) and, in addition, of the numbers of scientists available to industry, government and the university itself.

In Graph 6, the growth patterns of PhD output in the United States are plotted for the years 1966-74. Together with Table 4, this graph makes it possible to compare the actual output of PhDs with the output forecast in 1965. These data show a striking decline in the numbers of males obtaining doctorates in the physical sciences, and to a certain extent in the life sciences and engineering. On the other hand, no such changes are visible in education, the social sciences or the humanities. Indeed, including both males and females, the total output of PhDs in Physics and Engineering were well down on the estimates made in 1965.

Similar data are available for Sweden. In this case, the output of doctorates peaked in the early 1970s and, with the possible exception of medicine, has been declining since then (see table 1). The decline in PhD output during the 1970s cannot be accounted for - as directly in the United States - by a general cutback in funds for universities or a decline in student enrolments. In Sweden, the numbers of candidates enrolling for doctorates has been constant. Jense (1) concludes that the decline in output is due primarily to the fact that students are unable to finish their studies in the prescribed four-year period.

1) G. Jense, The Swedish Academic Marketplace (Student-litteratur, Lund, 1979).

Table 4

NUMBER OF U.S. DOCTORATES, BY FIELD

Year	Eng.	Math.	Phys. Sci.	Bio. Sci.	For. & Agric.	Social Sciences	Psych.	Arts & Hum.	Educ.	Bus. & Comm.	Other	Total
1957	596	249	1 723	1 108	341	1 098	550	960	1 530	93	502	8 750
1958	651	247	1 694	1 125	340	1 106	572	910	1 640	105	552	8 942
1959	751	282	1 856	1 051	376	1 187	635	1 000	1 610	135	513	9 360
1960	789	303	1 906	1 207	440	1 237	641	1 070	1 590	133	513	9 829
1961	949	344	2 041	1 195	450	1 355	703	1 120	1 740	170	508	10 575
1962	1 207	396	2 180	1 338	465	1 365	781	1 185	1 903	226	576	11 622
1963	1 378	490	2 443	1 459	449	1 536	844	1 329	2 073	250	571	12 822
1964	1 693	596	2 524	1 625	555	1 779	939	1 505	2 346	275	653	14 490
1965	2 124	682	2 908	1 937	529	1 991	847	1 726	2 709	321	682	16 456
						Projected						
1966	2 453	805	3 090	1 981	559	2 198	1 035	1 888	3 125	319	746	18 199
1967	2 767	956	3 316	2 210	585	2 388	1 187	2 050	3 538	394	748	20 139
1968	3 159	1 121	3 543	2 519	612	2 647	1 380	2 225	3 913	420	806	22 347
1969	3 561	1 280	3 808	2 909	660	2 916	1 590	2 415	4 200	467	809	24 625
1970	3 924	1 450	4 032	3 271	696	3 185	1 821	2 638	4 450	572	869	26 879
1971	4 275	1 597	4 256	3 615	736	3 501	2 067	2 893	4 705	608	871	29 124
1972	4 637	1 792	4 577	4 314	790	3 895	2 361	3 180	4 930	662	932	32 070
1973	5 100	2 000	4 974	4 973	849	4 357	2 689	3 570	5 184	735	1 054	35 485
1974	5 583	2 210	5 484	5 685	919	4 849	3 050	3 985	5 470	826	1 120	39 181
1975	6 157	2 422	5 907	5 817	985	5 558	3 283	4 425	5 850	924	1 186	42 954

Source: J.K. Folgar, H.S. Astin, A.E. Bayer, 1970, p. 406.

The situation in Canada with regard to postgraduate enrolment is in some respects in contrast to the Swedish case. While total full-time graduate enrolments have increased between 1972 and 1978, both in aggregate and in the natural sciences, most of this increase is due to growth in masters level enrolments. PhD enrolments, in general, have declined, particularly in mathematics and physical sciences and in engineering and applied sciences. These declines are beginning to be revealed in data showing degrees awarded (see graph 7).

In table 5, the numbers of doctorates granted by the Netherlands' universities during the period 1969-1978 is displayed. In this case, the situation is complicated by the fact that there are no formal doctoral programmes offered in the Netherlands universities. Nonetheless, the overall trend would seem to be one of slow growth. At the same time, it appears that the production of doctorates is relatively independent of the proportion of research funds provided by the research councils - in this case ZWO (see table 6). Such would certainly not be the case in either the United States or the United Kingdom, in the latter case because the Research Councils are the main providers from public funds of grants for research students.

Table 5

NUMBER OF NEW DOCTORATES IN THE NETHERLANDS

	69/70	70/71	71/72	72/73	73/74	74/75	75/76	76/77	77/78
Humanities	100	195	173	168	173	152	168	170	200
Nat. Sciences	100	119	104	107	122	112	101	120	120
Soc. Sciences	100	102	92	116	113	94	120	126	128
Med. Sciences	100	113	116	121	94	125	119	142	161
Tech. Sciences	100	85	85	69	79	93	104	101	89
Agric. Sciences	100	130	125	200	150	195	105	190	205
Total	100	116	108	114	114	115	113	129	134

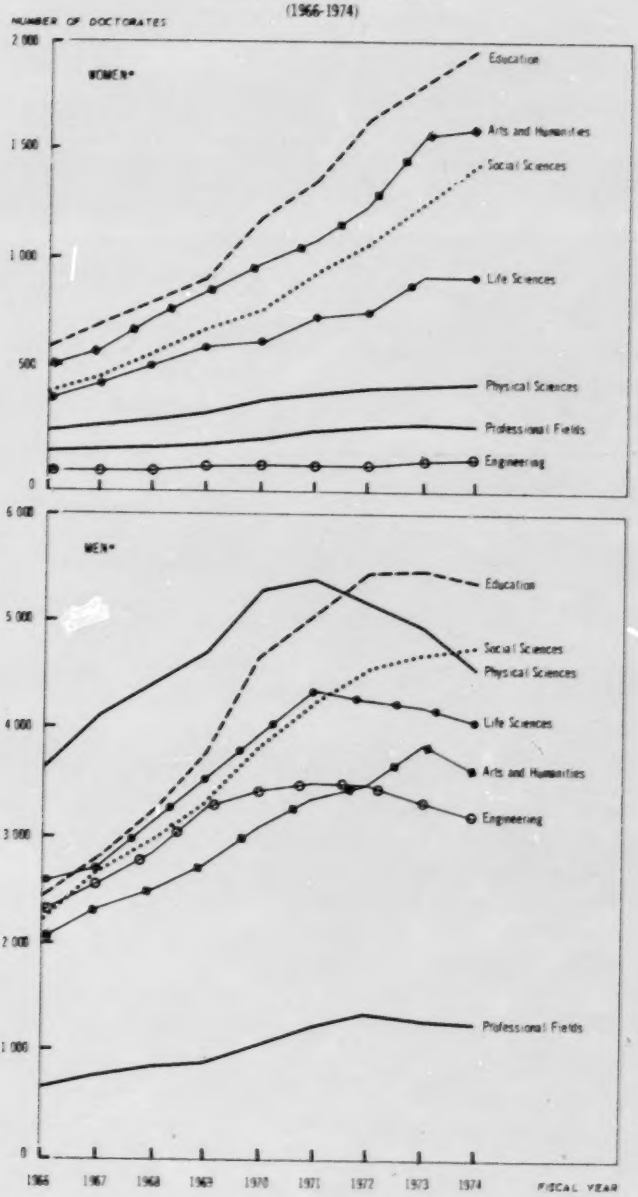
Source: BUOZ-nota, The Hague, 1979, p. 62.

It would be most valuable to be able to fill out this picture with more data on the output of PhDs and to get a clearer idea of its sensitivity to the modes of university funding. At present, conclusions about this aspect of the output of the universities rests on a fine judgement between sketchy data and the impressions of scientists and bureaucrats as to the current situation. It would be a relatively simple matter to remedy this deficiency of information.

Graph 6

NUMBER OF NEW U.S. PH.D's

(1966-1974)

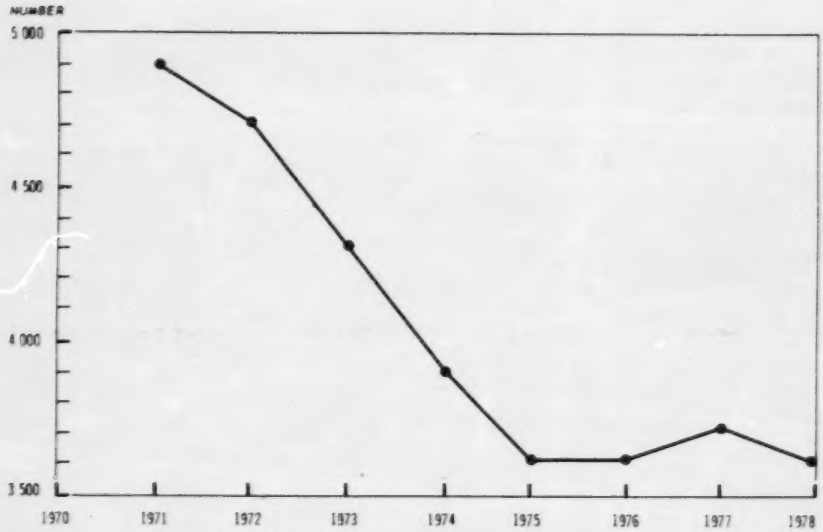


* Note that the vertical scale used for the chart for women is larger than that in the chart for men.

Source : 1974 *Summary Report of Doctorate Recipients from United States Universities*. National Research Council. Washington D.C.

Graph 7

FULL TIME GRADUATE STUDENT ENROLMENT IN CANADA
(Natural Sciences and Engineering)



Source : T.C. Clark, Canadian Research : The Anatomy of Neglect. A personal report to the University of Toronto, March 1978.

In summary, and given the lack of precise data on post-graduate training it still seems reasonable to conclude that a decline in numbers being trained is taking place in some countries. There are a number of reasons for this. In the first place, there is evidence (at least in the United States) that market forces influence - with a time lag of only a few years - students' decisions to embark on doctoral studies(1). Thus the highly publicised decline in recruitment to, and expenditure on, R&D activities may have driven graduates away from PhD work. In the U.K., while it is not possible to generalize about demand for Research Council grants for doctoral work in the wide range of different disciplines covered, there has been some shortfall of demand in certain fields, including projects with an explicit industrial input, for which awards have been readily available. In addition, financial constraints have recently affected student support particularly in the social sciences.

1) Projections of Science and Engineering Doctorate Supply and Utilisation, 1982 and 1987, NSF, 1979, p. 303.

A working party of the Advisory Board for the Research Councils is currently investigating how far the present provision for postgraduate education in scientific fields supported by the Research Councils is meeting manpower needs.

In Sweden, where the fall in the output of PhDs has been drastic, (less than half as many graduated with a PhD in the natural sciences in 1975-76 as in 1969-79) somewhat different factors seem to have operated (see table 1). Here, it may be that changes in the structure of education have had the largest influence. In addition, it may be that other less tangible effects of changes in the social composition of the student body following from the "democratisation" of enrolment have yet to be felt. Substantial numbers of undergraduates are now admitted on the basis of age and work experience. This could eventually reduce the research base for entry into postgraduate education. It would be unsurprising if those graduating much later in life were more reluctant to add to the duration of their studies.

However, this decline in the production of PhDs is not universal. In those countries now moving towards a more professionally orientated doctorate, such as Finland, Netherlands and Norway, expansion is much more likely. This trend towards expansion will probably become true of Greece, where the merits of the professionalised PhD are just beginning to be debated. It must be remembered that these countries, whatever their subsequent rate of expansion, are beginning from a very low baseline; there is, as it were, a vacuum into which expansion can occur. Similarly Germany and France, both of which have relatively recently introduced special schemes to provide stipends for students to prepare their doctorates neither wish, nor are likely to, suffer declines in PhD output.

But whether the national trend discloses increasing or decreasing numbers of post-graduate students, judgements about their significance depend upon the aims and purposes of post-graduate training. If post-graduates are intended to provide a scientific elite trained in the most advanced techniques, choices will have to be made about the areas where this type of training is most needed. These choices will carry a further implication for the university research function, because the research base has been seriously weakened during the past decade and many universities are working with obsolete equipment: a scientific/technical élite for the 1980s cannot emerge from an infrastructure geared to the scientific and industrial requirements of the 1960s.

d) Availability of Equipment for Research

The statistical data presented earlier in this report show for almost all countries (Denmark and France being exceptions) a small, real

decline in total R & D expenditure per research scientist. But, these data do not show that per capita capital expenditure (which includes provision for the more expensive types of instrumentation and equipment) has declined drastically since 1970 in many countries (most strikingly in Belgium and the Netherlands). The situation expressed by this second indicator is a more reliable guide to the actual resources available to university scientists, since total research expenditure per scientist includes the individuals' own salaries (not a research resource) as a major element.

Discussion with scientists and with some research councils has indicated that universities are increasingly unable to provide an adequate base of research equipment from their normal operating budgets. In Germany, for example, the DFG finds that scientists are increasingly including in their applications requests for major equipment which it would once have been thought normal for the university itself to provide. In some countries, both the research councils and, where they exist, private foundations have attempted to help universities in the maintenance of well-equiped laboratories.

The implications of this are not clear. Simple economic reasoning suggests that if capital investment per scientific worker is reduced output is likely to fall. But such reasoning might not be applicable here, and indeed there is some evidence that the level of provision of capital resources has no effect on research productivity.

The understanding necessary to resolve this paradox is severely limited by the data available. There is as yet no clear indication of the relationships which exist between inputs to the research process and the corresponding outputs. It is arguable that increased specialisation in university research coupled with new ways of sharing equipment may have led to a more economical use of resources, with no very marked effect on the quality of the research results produced; but this remains an empirical proposition which has yet to be put to the test. Nonetheless it is still widely believed to be the case that, in some fields, scientists are increasingly being restricted in the research they can undertake by the difficulties of obtaining advanced equipment.

In most OECD countries renewal of the technical infrastructure on which contemporary science is based is raising serious problems. Governments will have to devise new ways to meet this requirement, but within strict cost limits. There is here a potentially powerful lever on future university research and, because it must come, it should be seized, by university and government alike, for what it is - a unique opportunity for genuine development.

e) The Balance of Scientific Effort

There are two issues to be considered here. First, the possibility that the balance between "fundamental" (i.e. research motivated primarily by the internal dynamics of the discipline), and "short-term", or "applied", research may be tipping too far in the direction of research directly oriented to social and economic needs (1). Secondly, it may well be that a slow evolution in the distribution of university scientists between disciplines is taking place. As far as the latter is concerned, it is of course the case that the numbers of university scientists, to some extent and with some lag, will follow the pressure of student demand as reflected in enrolments, since this determines the number and types of university posts available. Indeed, it is precisely this fact, coupled with a desire to ensure that the distribution of research resources between fields is not determined principally by student choice of field of study, that has underpinned some of the attempts at "decoupling" the research and teaching budgets: the Netherlands would be a good example of this phenomenon.

Statistics on new entrants to universities by field of study seem to indicate that in many countries a significant decline in the proportions choosing to take up science at university took place between the mid-1960s and the mid-1970s. In France, for example, the fall was from 29.8 per cent (1965) to 15.4 per cent (1975). Other countries had smaller changes, but in the same direction; for example, Australia, Belgium, Finland, Italy and the United Kingdom. In a few cases this was accompanied by a rise in the proportion studying technology and/or the medical sciences, as in Finland and Italy. In a smaller number of OECD countries there was an increase in the proportion of new students choosing to study science in this period; in Germany 15.5 per cent in 1965 rising to 21.2 per cent in 1974; in Sweden 3.4 per cent in 1965 rising to 11.9 per cent in 1972.

For a few countries for which sufficiently detailed information is available, the indications are that the distribution of university research expenditure has moved in similar sorts of ways. In Australia and in Norway, for example, there has been a reduction in the share of natural science expenditure and an increase in medical research expenditure.

1) Some data are available on the distribution of research effort between fundamental and applied research in various disciplines. But, as has been indicated it is not the balance between fundamental and applied that is at issue. The crucial distinction is between fundamental research oriented to social and economic objectives - "strategic research" - and short-term research which is attempting to respond to pressures for immediate relevance. That universities must and can play a role in the execution of strategic research is not disputed; that they should play a role in the immediate and short-term solution to society's many problems to any significant extent is doubtful.

Clearly, the influence of teaching requirements upon the university research effort will be the greater, the larger the share of university research financed through normal university budgets. To the extent that their research is financed from external sources (research councils, government departments, industry) the universities will be protected against pressures to become purely teaching institutions. But to that extent also, they will be open to the influence of demands for short-term problem-solving on their overall research capability.

In some countries the share of external funds is not only large but growing. In Australia and in Canada, for example, some 40 per cent of university research is financed from funds of this kind. In others in which this mode of funding plays a relatively small part (e.g. Greece, the Netherlands) many argue that this share must grow substantially. Clearly a funding pattern of this kind permits universities to play a more coherent part in a national and co-ordinated science policy. It also implies however (as some academic scientists in Greece and the Netherlands argue) that the universities are thereby much more under the influence of the short-term preoccupations of policy makers. There is thus a danger of university research becoming too short-term, too applied, with serious effects upon the level of "fundamental" research. Much of course depends upon the extent to which funding organisations (e.g. research councils) are themselves subjected to pressures of this kind, and on the way in which they interpret their role.

At one extreme, the German DFG and the Netherlands ZWO are relatively autonomous and immune from pressures toward short-term relevance. The priorities of the DFG, for example, are essentially scientific priorities. Similarly, in the Netherlands it is the intention to evolve a system of research priorities from within the scientific community. This is not the case everywhere. And in Canada, although external funding as a percentage of total university research effort has been more or less stable, the research council share of this external funding has fallen: the balance comes from a rapidly growing involvement on the part of the provincial governments.

What is at stake here is the question of the function of the university, and its research capability to meet the demands of society. To the extent that government controls - either directly or indirectly - the funds available to the university, the determination of that function becomes a matter of government policy. Thus, policy-makers should be aware of the danger that universities may become too involved in short-term research at the expense of the development of their overall research capability and of the time-scale involved in replacing intellectual capital.

Research priorities need to be determined in dialogue with the scientific community. This will face policy-makers with the need to develop new modes of participation in decision-making and to resist the natural bureaucratic propensity to centralise control. There are now a wide range of experiments of this kind on which policy-makers can draw for assistance in developing more participatory modes of decision-making.

f) Changing role of the Research Councils

Traditionally the research councils have been the organisational embodiment of the relative autonomy of the scientific community. Their position as "buffer" organisations between the political arena and the scientific community guaranteed the allocation of research funds according to the criteria of the scientists themselves. Accordingly, research councils interpreted their role as a responsive one, awaiting the research proposals submitted by (university) scientists.

In the last decade, however, the role and functions of research councils in most Member countries have been enlarged. Policies directed towards more selectivity and concentration as a result of scarcity of resources on the one hand, and policies oriented towards the attuning of scientific research to socially relevant goals on the other, implied a far more active role on the part of the research councils, as well as the extension of their activities to new areas, such as national programmes.

The policy of the British SRC, oriented towards more selectivity and concentration in its support of university research, and the German DFG's "Sonderforschungsbereiche", are examples of the former tendency. Interventionist modes of funding directed towards science-external goals are implemented in the policies of some research councils in quite different ways: the national programmes executed, for example, by the FNS (Switzerland) and the CNR (Italy); the establishment of a new NAVF sub-council for societal planning in Norway; the French DGRST "actions concertées"; et cetera.

These changes in the definition of the tasks of research councils affect, as well as reflect, their position between the scientific community and the governmental sphere. It could be surmised that, for these councils, some kind of tension can arise between the demands internal to science on the one hand and the increasing demands external to science on the other. In this light one can understand the complaints raised by some university scientists that it seems as if research councils are begining to act like instruments of Government, with an increasing emphasis upon committed funds.

The importance of developments in the sphere of the research councils are all the more significant for university research because they accompany the growing importance of research council funds for research. It therefore seems necessary to assess to what extent they are still able to state scientific priorities, and thereby still able to plan their intermediary role with respect to protecting research quality and also to coordinating scientific research in the universities.

The growing tension between these two aspects of the research council role - perhaps increasingly incompatible - must be noted. These aspects of the role of research councils become even more important when we see that, as in the case of The Netherlands' ZWO, it is proposed that research council financing should have the character of a 'revolving fund' - that is, that periodically there should be an assessment of the extent to which research council financed research can be transferred to the university's own funds.

On the other hand, however, research councils can play a significant role in the translation of socially relevant problems in terms of research. Given their expertise, they are in a prominent position to assess the legitimacy of the problems directed from society to science.

Accordingly, policy makers should pay explicit attention in this context to the changing role of research councils vis-à-vis the diverging demands of the scientific community and the rest of society, and to the tensions brought about by this divergence.

2. FUTURE PROSPECTS

It now remains to try to assess the implications of these trends for the ability of the universities to meet the demands that are likely to be made on them.

This report is not an exercise in social and economic forecasting, and it is not possible here even to try to provide an assessment of developments in the economy and society which might characterise the environment of the 1980s. All that can be attempted is a brief indication of the aims which governments might be expected to pursue and an assessment of the contribution which the universities, through their research capabilities, might make to the attainment of these goals. There can be few certainties in an exercise of this kind. Nonetheless, two observations would seem to provide a reasonable basis from which to begin.

First, it seems likely that the most visible and politically salient function of the universities will continue to be an educational one. Typically, in OECD countries today some 20 per cent of young people

Table 6

TOTAL INTRAMURAL EXPENDITURE AND OUTPUT OF DOCTORATES IN TWO FIELDS OF SCIENCE IN THE NETHERLANDS (%) (1)

	Prop. of ZWO financing by field		Total HES %		Number of doctorates %	
	69-71	74-76	69-71	74-76	72-73	77-78
Natural sciences	.21	.20	59	58	64	60
Medical sciences	.04	.05	41	42	36	40
			100	100	100	100

1) Percentages are calculated on the basis of tables 2.5, 3.6 and 7.1 in Appendix A of BUOZ-nota, The Hague, 1979.

between the ages of 18 and 20 enter the university; and many more enter other kinds of higher educational institutions. Thus, higher education, because it affects a relatively large proportion of the population, will continue to demand a significant contribution from national resources. As a consequence, the future of the university in the Member countries is likely to be determined far more by educational policy than by questions relating to research.

Second, the seemingly intractable problems of today - inflation, unemployment, the supply and price of energy, the effects of new technologies, especially biotechnologies and microprocessors, the problem of inner cities, the relations between the ever-rising costs of health services and the continually rising demand for care - are likely to continue and to remain at the top of most political agendas. The very urgency of these problems will create the boundary conditions within which the university will evolve.

Thus, although this report earlier identified five functional areas for university research, it is unlikely that cultural or purely scientific goals will play large parts in either social consciousness or government policy. This may be a mistake. For it could be argued that it is more important today than ever before to learn to learn from the past; to understand the effects of changing social conditions on values and beliefs. However, it is most unlikely that a thesis of this kind will compete effectively when governments are faced with a pressing need to "do something" about so many pressing practical problems. It is therefore not to do too much of an injustice to the future to focus, in particular, upon university research in relation to the economy, to social development and to education.

a) Research and Economic Growth

So far as the economy is concerned, there seems little doubt that today's problems of low growth, unemployment and inflation will continue to be major preoccupations of governments. A convenient starting point for considering the role which university research may play in helping to tackle these problems is provided by the recent OECD study, Technical Change and Economic Policy. This study reaches five central conclusions of importance for the present analysis:

i) there is a correlation between (innovation-derived) productivity growth in a given sector of the economy and the tendency of prices in that sector to remain relatively stable (cf. electronic goods and textiles);

ii) thus productivity growth, through an increase in innovation, could be an important instrument of anti-inflation policy in the medium to long-term;

iii) the decline in the rate of increase in productivity has not only contributed to inflation but to unemployment; continuing failure to stimulate productivity, through innovation, will make the unemployment problem all the more difficult to deal with;

iv) whereas radically new technological change generates employment, minor improvements to products or processes (which will include application of the now well-established microelectronic technology) tend to result in the substitution of capital for labour, and hence add to unemployment;

v) in fact, there has been a more or less continuous decline in the tendency of industry to invest in longer-term research; emphasis has increasingly been on R & D directed to minor improvements in existing technologies.

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Table 7

FORMS OF RELATIONSHIP BETWEEN UNIVERSITIES AND INDUSTRY IN THE UNITED KINGDOM

Ways in which universities and industry can collaborate:

1. Personal assistance from industry with university activities:
   - Lectures by industrialists at universities.
   - Industrialists serving on university and faculty committees, etc.
   - Industrial advice on, and provision of problems for, research.
   - University staff and students visiting industry.
   - Industrial advice on curricula.
   - Use of industrial laboratories for higher degree work.
   - Secondment of industrial staff to work at universities.
   - Technical advice of assistance.
   - Use of equipment or facilities in industry.
   - Instrument development.

2. Use of university staff and facilities:
   - Industry using more consultants.
   - Industry sponsoring research at universities.
   - Provision of special advisory or consultancy services.
   - Secondment of university staff to work in industry.
   - Refresher or retraining courses.
   - Industry sponsoring sandwich students and also providing suitable training.
   - An increase in multidisciplinary projects.
   - Use of facilities or equipment at universities by industry.

3. Joint activities:
   - Joint research programmes with work at university and in industry.
   - Interchange of staff.
   - Joint supervision of students.
   - Local "science-based" industry developing from university departments.
   - Joint meetings or colloquia.
   - Joint appointments.

4. Positive role of "third parties":
   - Industrial Liaison Centres run by universities.
   - Science Research Council Schemes for improving contacts:
     (a) Co-operative Awards in Pure Science (CAPS);
     (b) Industrial studentships and fellowships;
     (c) Awards for science, industry and school teaching (ASSIST);
     (d) "Instant" awards;
     (e) Graduate schools;
     (f) Support for collaborative research grants.
   - Research Associations translate research into technology for smaller firms and feed back to universities.
   - Ministry of Technology industrial Units.
   - University Grants Committee "pump-priming" support for schemes of assistance to industry.
   - Professional institutions encourage joint activities and influence curricula by professional requirements.
   - Min. Tech. industrial liaison officers encourage university-industry links.

5. Financial (or similar) support from industry for university activities.
   - Grants for research without a fixed timescale or agreed programme.
   - Grants for studentships, fellowships, etc.
   - Loans or gifts of equipment.
   - Endowment of a chair or university post.

Source: CBI, Industry, Science and Universities, 1970, Table 64.

b) A Changing University/Industry Partnership

The implications of this for the relations between industry and the universities would seem to be as follows.

Industry has become increasingly unable, and unwilling, to invest in R & D directed towards the development of fundamentally new technologies: but it is, precisely, radical innovations which are needed if low productivity growth, unemployment and inflation are to be tackled successfully. What seems to be needed is substantial investment in "strategic" research: that is to say research addressed neither to problems of immediate short-term relevance nor to problems which derive their interest solely from scientific theory but having as a background a practical orientation. It is via the performance of such research that the universities could make a significant contribution to the economy.

However, the encouragement of a substantial investment in strategic research carries with it a number of implications for the ways in which overall research policy is formulated. While not all strategic research is necessarily industrially oriented, a significant fraction of it will be so. What this implies is that universities will have to be enlisted in the service of a broadly determined national science policy. It will not suffice either to allow universities to devote all of their resources to research of purely scientific interest or - and in many countries this is the greater danger - to drive the universities too far towards the performance of research of immediate, industrial interest.

Clearly, the development of priorities for strategic research must involve the close collaboration of the universities with both industry and government. Industry, in particular, will have to become involved, because the development of policies related to industrial strategy have profound implications for the areas of strategic research to be given priority; the types of equipment to be purchased for university laboratories; and the kind and quantities of postgraduate students to be trained. It will, therefore, be essential to devise mechanisms for formulating research goals of this strategic kind, while keeping in mind both national sectoral priorities and opportunities for manufacture, and an assessment of scientific potential.

Such mechanisms do not exist in most countries. Nonetheless, it will certainly be inadequate for research sponsors (e.g. the research councils and, to an increasing extent, government departments) to formulate priorities either in isolation from the scientific community, or from representatives of industry and the trade unions. This is too frequently the case and science policy priorities developed in isolation have proved to have had little impact upon the research interests and activities of scientists.

At a more practical level, the development of strategic research will involve the creation of new and different types of university-industry relationships. The question of the importance (or otherwise) of university-industry links is a perennial one. The impression gathered in the course of this investigation is that it is more a preoccupation of some countries (e.g. Canada, Australia, United Kingdom and United States) than others (e.g. Netherlands, Germany), and that concern for the enhancement of university-industry collaboration is closely correlated with economic performance. In general, those countries with sound economic performance seem less concerned with the problem, while those whose economies are currently experiencing some difficulty see closer university-industry links as one important route towards improving their situation. It is clear, then, that university-industry links do exist; that they are complex and multi-faceted, and that they have grown up in a variety of different circumstances. In no case have they been legislated into existence.

An example of the range of university-industry links operating in the United Kingdom can be seen in Table 7. No doubt similar tables could be constructed for most OECD countries. The point to be made is that in the United Kingdom, as in many other countries, discussion about university-industry collaboration is being hampered by the presence of a stereotyped view on both sides - stereotypes that were formed, in some cases, over fifty years ago but nonetheless appear very resistent to change. This is worrisome because there is an urgent need for even closer collaboration and for greater flexibility on both sides. In addition, as had been indicated, such flexibility is being hampered by almost total stagnation in university recruitment.

There is thus a need for a fuller investigation of the mechanisms whereby university-industry collaboration takes place and of the needs for new forms of collaboration implied by the creation of national policies based on the idea of strategic research priorities.

It may well be that many of the opportunities identified, and hence areas chosen as research priorities, will require new mixes of skills. The emerging "biotechnologies" are an example. In very few countries are university structures, and funding mechanisms, well adapted to the creation of multidisciplinary research groups. Groups of this kind are likely to require guaranteed funding for a substantial number of years. Government departments, and research councils, to the extent to which they are under government pressure, are less and less willing to offer funding on this basis in the present economic-climate. Nevertheless, it will be essential that groups working in research areas defined as having strategic priority have the opportunity to train sufficient numbers of scientists in a professional way, and this cannot be done on a short

time scale. It will be through the migration of these scientists into industry that the new knowledge will be transferred.

Special schemes of support for graduates wishing to pursue advanced study in strategic areas may be required. This is a far from simple process to establish because of the implications that it has for the professional and career prospects not only of postgraduates but for the scientists who undertake to train them. Moreover, various studies of the determinants of scientific research effectiveness have shown that the commitment to research of the leader of the research group is crucial.

However, in many important respects these requirements conflict with the trends in the functioning of the university research system which have been identified in this study:

- inflexibility caused by falling recruitment;
- the consequent ageing of the university community;
- the difficulty of creating new research fields;
- the increasing dependence of universities on sources of funds which focus on short-term problems;
- the decline in postgraduate training, and its relationship to attempts to decouple teaching and research.

Nonetheless, the idea of strategic research and the policy implications derived from it can be seen to take into account the complexity of the problem and to provide a starting point from which policy options might be developed.

c) Research and Social Development

Much of this analysis has relevance for the role of the university system in relation to social policy. Such policy is, in part, bound up with the current economic situation: growing unemployment, lack of opportunity for school leavers without academic qualifications to find employment, the effects of inflation on standards of living, and so on, are central to social policy. Policies adopted in the social area have, however, all too often failed because of a lack of understanding of the social reality. As a consequence, research commissioned in furtherance of social policy goals has been similarly constrained by a preoccupation with the quantification of well-recognised problems and the evaluation of unimaginative "solutions". Alas, this diagnosis is far from novel! (1)

It is therefore important to point out the necessity of "strategic research" in these fields too. Social science research in the universities is increasingly squeezed between, on the one hand, a growing dependence upon government funding for projects of immediate relevance

1) Social Sciences and Policy Making, OECD, Paris, 1978.

and, on the other, a traditional disciplinary commitment to pure theory. Here, too, research involving several disciplines is essential: problems of the environment, medical care, leisure, occupational health, and so on, do not correspond with the approach of any single discipline. Not only in the natural sciences, then, but in the social sciences also will policy-makers need to explore novel forms of collaboration while at the same time ensuring that the social sciences are given enough support to maintain the buildup of their intellectual capital.

Yet there is, on the whole, rather little co-operation between specialists from the medical and natural sciences, and social scientists. This has serious implications at a time when it is realised that many of society's most pressing problems require a blending of the natural and social sciences for their solution. For example, in such crucial areas as the development of energy alternatives, pollution and environmental control and industrial innovation, it is clear that adequate solutions will involve close attention to both technical and social considerations throughout the problem-solving process. Because it is no longer possible to regard energy policy, the provision of clean air or the enhancement of productivity as merely technical problems, there is a pressing need for the development of multi-disciplinary research capabilities.

Moreover, it is widely recognised that many of today's social (and socio-economic) problems require the formulation of solutions locally, rather than centrally. The tendency of many countries to relate the foundation of new universities to regional development in the 1960s (e.g. Finland, France, Norway) showed recognition of the contribution which universities could make to local community regeneration. Of course, the days of the establishment of new universities are over. Once more, therefore, new means of establishing priorities are needed. Once more, the need for new mixes of skills must be recognised.

The prognosis follows that developed above in relation to economic problems. But, insofar as it is the social sciences which have to make a major contribution in the social area, certain special problems will have to be faced. One of these is the vulnerability of the social sciences to political disputes and, related to this, the danger of politically biased opposition to the social sciences. If they propose to invoke the assistance of the social sciences, policy-makers will have to understand and diffuse widely the many important ways in which social science differs from natural science and how the notion of "applied" science differs in the two contexts. This is especially important in those areas of social concern which require that the natural and social sciences be brought together.

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A further important point concerns the relative expansion of employment in the service sector in many OECD countries. If the service sector is to become more innovative, opportunities for the employment of people trained in research must be expanded. It is only in this way, just as in the transfer of knowledge to industry, that the results of research will permeate service organisations.

d) Research and Educational Development

There remains, finally, the future contribution of research to the educational function of the universities. Of course, these two functions interact at many levels. Education feeds research by providing recruits, and also by providing the stimulus to reflection on the integration of various specialisms. Nevertheless, it also constrains the amount of research which can be carried out, as the preceding analysis has shown. In addition, it is likely that changes in the knowledge requirements of the professions will continue to exert pressures for changes in university curricula (for example when the development of bio-technologies gives rise to a demand for new types of engineering). This, in turn, implies certain restrictions on the type of research which will be encouraged. These constrants are likely to continue.

Though university enrolments are now more or less stable in many countries, demographic data suggest that there will be another increase in enrolment in the late-1980s. It is also likely that there will be increasing pressure on the universities to produce graduates more "efficiently" - that is, at lower cost. Experimentation in the provision of higher education has now more or less ceased. However, because higher education is now very much an object of political debate (on account of the high participation rates which many OECD countries now enjoy), it is difficult to know to what extent political and social factors will bring about radical changes in the student body. Demands that admission be made more democratic - in term of age groups, ethnic minorities, women - could become fiercer, and this would have a major effect on the subjects chosen for study. It is these educational requirements which are likely most significantly to determine the future shape of the universities. The argument of this report is that research in the university, though less politically salient, less visible, has an indispensable contribution to make to the future, and that steps must be taken to protect and promote its viability no matter how educational requirements develop.

But a part of this contribution to the future is to education itself. The old view that education and research at the university level are inseparable has begun to break down in the face not only of economic stringency but also of reflection upon the meaning of this belief. The

report has shown how a number of things have followed from this. Research and teaching are tending to grow apart. The need to protect the research element of the university budget has, in some cases, led to a separation of what used to be an indivisible budget (especially in Sweden and the Netherlands). Ideas that universities need to specialise in areas of research, concentration of resources, as well as lack of funds, is leading to a restriction of research to one part of the traditional university.

At the same time, in some Member countries the growing student numbers of the 1960s were accommodated by relatively greater expansion of the non-university sector of higher education. Not least because of its lack of research, and more vocational character, this seemed an economically sensible thing to do. This trend is likely to continue. The result seems to be that, on the one hand a declining proportion of graduates are likely to receive their higher education in institutions in which any research goes on; on the other hand, a declining proportion of teachers in higher education are likely to engage in research. Swedish experience, with a clear distinction between two career channels in the university, is an anticipatory glance at the possible future, and one which has already caused some rethinking. It may be true that all university teachers need not be continuously engaged in research. It does not follow that higher education can largely be provided by individuals who have no involvement in research. The proper relationship between the two is now uncertain: almost certainly there are many ways in which the benefits for education of proximity to research can be brought about. An OECD study carried out some 7 or so years ago (1) showed that many attempts at developing new relationships in practice were then being attempted. Today experiment may have largely stopped. This is unfortunate.

The fact is that, in the light of the previous analysis, economic opportunity is likely to be created by new technologies, based upon new mixes of skills. The same could well be true of the service sector. The rapid change which will be an essential accompaniment of economic and social regeneration in the mid to late 1980s will require graduates educated on the basis of up-to-date research knowledge. Curricula will have to keep pace with developments in science and changing professional roles. There are too many examples of the "dis-qualifying" effects of rigid inflexible curricula: a traditional criticism of the the non-

1) S.S. Blume "New Teaching-Research Relationships in Mass Post-Secondary Education" in Structure of Studies and Place of Research in Mass Higher Education, OECD, Paris, 1974.

university vocational sector. Means of maintaining some connections between university research and all higher educational teaching have to be found, despite short-term financial/efficiency considerations. There are many possibilities, such as regular and frequent 'research sabbaticals', to be spent perhaps in the university's own Institute of Advanced Studies. Experiment and thought in this area must not stop.

It is a new truth, not scepticism, which must replace the old belief in the indivisibility of research and teaching.

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